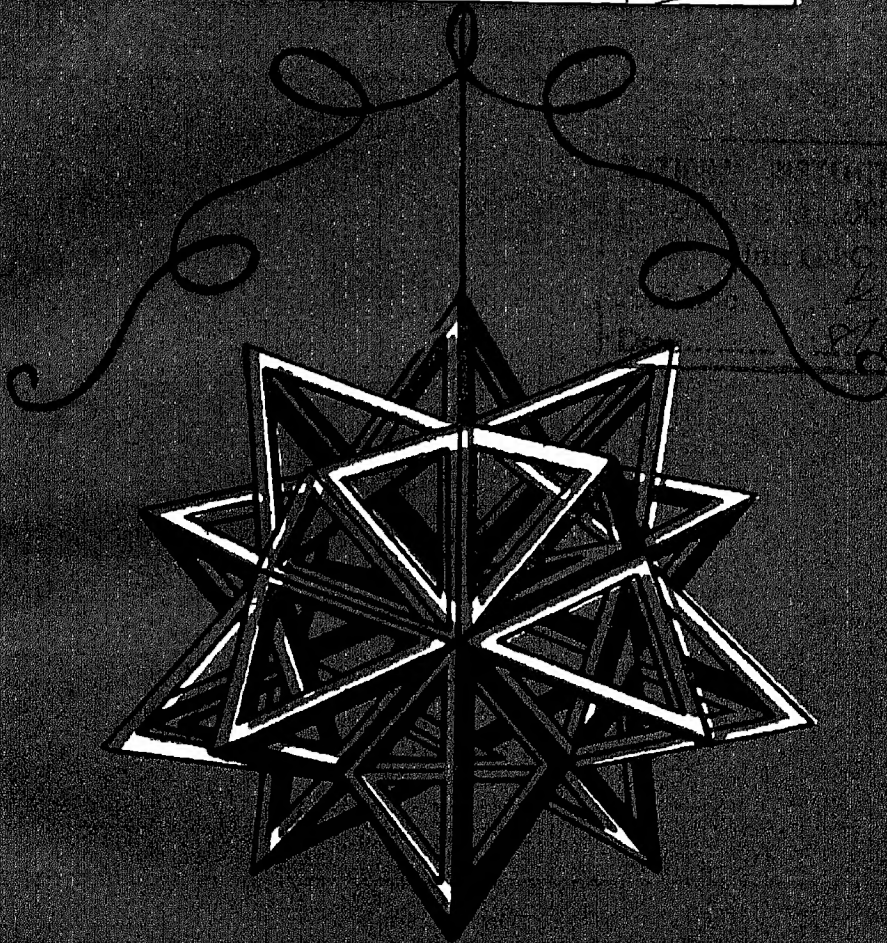


SCHOOL SCIENCE

3/ Vol. XXVI No. 3 September 1988

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*A geometrical construction
by
Leonardo da Vinci*

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SUBSCRIPTION

Annual ; Rs. 16.00

Single Copy : Rs. 4.00

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Evaluation of Students' Achievement in Science

MAPLOW EDIGER

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Formative and summative evaluation are two concepts that science teachers need to understand and implement. Formative evaluation stresses the appraisal of learner progress as the science unit is being taught. The teacher then needs to assess within a lesson if goals are being achieved by pupils. Feedback from students within each lesson provides teachers with information as to which objectives and learning opportunities need to be emphasized sequentially. Summative evaluation, on the other hand, views results from learners at the end of the science unit. Past test results are an inherent part of summative evaluation. From summative evaluation, the science teacher notices changes that need to be made in teaching the science unit the next time or during the coming new school year.

There are diverse means available to appraise learner progress in science. Valid, reliable methods must be utilized to ascertain which understandings, skill, and attitudinal objectives each student has attained. Achieve-

ment of students must be evaluated rather continuously. Thus, a criterion check is in evidence as the science teacher appraises if a student has/has not attained sequential objectives.

Formative and summative evaluation are two concepts that science teachers need to understand and implement. Formative evaluation stresses the appraisal of learner progress as the science unit is being taught. The teacher then needs to assess within a lesson if goals are being achieved by pupils. Feedback from students within each lesson provides teachers with information as to which objectives and learning opportunities need to be emphasized sequentially. Summative evaluation, on the other hand, views results from learners at the end of the science unit. Past test results are an inherent part of summative evaluation. From summative evaluation, the science teacher notices changes that need to be made in teaching the science unit the next time or during the coming new school year. The question then arises in summative evaluation how one might teach the completed science unit differently to optimize student achievement in science.

Using Anecdotal Records

The teacher needs to record representative, unbiased behaviour of each student when sequential lessons and units in science are taught. A teacher writing anecdotal statements for two students each day can make the rounds once for each student in approximately twelve school days, e.g., one teacher for twenty-four pupils.

In writing anecdotal records for each student throughout the school year, the science teacher needs to be guided by the following criteria.

1. Factual accounts should be written. Record exactly what happened. Do not use loaded words, such as eager, energetic, lazy, indifferent, irresponsible, among others. If a student, for example, was clear and accurate in describing the process of photosynthesis,

an unbiased statement can be written and dated for the involved learner.

2. An adequate number of anecdotal statements need to be recorded for each student. Only then, will a science teacher notice a pattern of behaviour for each student. A teacher can forget specific, representative behaviours unless they are recorded. If the successful student in criterion number one above attaches meaning to concepts in science, such as volcanic eruptions, earthquakes, folding, faulting, erosion, and tremors, a pattern of behaviour will be noticed from anecdotal statements recorded systematically by the science teacher.

3. Skills and attitudes also need recording. The ability of the student to identify problems, gather data, develop hypotheses, test hypotheses, and revise, if necessary, are vital processes and skills for students to develop and teachers to record in anecdotal form. Developing positive or negative behaviour in anecdotal record form can provide valuable information to teachers in terms of objectives needing emphasis in the science curriculum.

Using Rating Scales

When objectives cannot be quantified, the teacher may utilize rating scales to appraise student progress. Affective goals are difficult to write in measurable terms. Thus, more open-ended objectives in the area of attitudes may be listed on a rating scale.

The rating scale may have ratings from five to one. Five being the highest and one the lowest may be utilized on the rating scale. Or, excellent, very good, average, below average, and poor can serve as criteria in the rating process.

Which attitudes in science might students achieve on a rating scale?

1. appreciating scientific methods utilized in gathering data, such as identifying and testing hypotheses.

2. desiring to learn more about each science unit being pursued.

3. revealing feelings of curiosity in diverse lessons taught in science

4. respecting contributions of scientists in improving situations in life

5. valuing the diverse academic disciplines that provide content in the science curriculum.

There are selected criteria to follow in writing statements pertaining to attitudes when utilizing rating scales. These include:

1. write each behaviour as precisely as possible

2. realize that subjectivity is involved in rating students

3. utilize the rating scale in a manner which minimizes bias, such as the halo effect.

4. have a colleague appraise the same attitudes to secure interscorer reliability.

5. use the rating scale method of appraising student progress at frequent intervals

6. incorporate rating scale results with information from other appraisal procedures to evaluate student progress

Using Checklist

The science teacher may use specific objectives placed on a checklist to assess learner achievement. Thus for each student, behaviours may be checked if they have/have not been attained. The following is provided as a model in developing a checklist.

Name of student Date

Specific Objectives

1. Is able to list in writing five causes for changes on the earth's surface.

2. Can state causes of sheet erosion, gully erosion, earthquakes, volcanic eruptions, and tornadoes.

3. Is able to make an accurate model or drawing of each of the concepts in objective two above

4 Can write a fifty word paragraph on the water cycle ; extinct prehistoric animals ; and the ice age

Each numbered item or concept is to be checked if a learner has been successful in goal attainment

Considerations to emphasize in writing behaviours for a checklist include

1. Measurability Each behaviour listed must be precise. Achievement of the student is then appraised in direct harmony with the precise end

2 Relevance. Objectives contained on a checklist must be significant and not measure trivia

3 Consideration for individual differences. Students vary from each other in capacity, achievement, and attitudes. Thus, the science teacher needs to take into consideration the unique rate at which a student will make progress in acquiring precise behaviours.

4. Sequence There is a selected order of objectives in which pupil can benefit optimally. Objectives must be sequenced in a manner which facilitates achievement.

Discussions

There is much that science teachers may learn about student achievement in ongoing units of study through the discussion method. The teacher must be a quality leader of discussions. Students individually need to be stimulated to participate in the discussion setting. The science instructor may then observe the the following pertaining to pupil progress within the discussion framework :

1. quality of facts, concepts, and generalizations revealed by students
2. ability to organize subject matter sequentially when presenting content orally.
3. attitudes towards science and the scientific method
4. skills in utilizing a variety of reference sources to secure useful content in a discussion.

5 levels of cognition from lower to higher levels, such as recalled facts, understanding what was recalled, using understood content, analyzing ideas, integrating content, and appraising conclusions gained.

There are numerous subskills to be appraised also, such as learners

- 1 speaking in meaningful sentences
2. staying on the topic being pursued
3. using stress, pitch, and juncture appropriately.
4. emphasizing sequential ideas
- 5 revealing enthusiasm for learning.
6. presenting ideas with clarity and fluency.

A good science teacher does a high quality job of appraising student progress. Results from students in the evaluation process should be utilized to improve the curriculum.

Teacher Written Test Items

There are numerous kinds of test items which may be written by the science teacher to ascertain student progress

One kind of teacher-written test item is the true-false test. In writing true-false items, clarity is important. The following is an example of a true-false item :

Liquids, solids, and gases are three states of matter.

The true-false item is true and leaves no leeway for interpretation.

In writing true-false items, the test item must be :

1. Either true or false. Vagueness in true-false test items needs to be omitted.
2. Valid. Each item measures what was taught and is reflected in the objective.
- 3 Reliable. Thus, if students respond to the same items, consistency of results will be in evidence from the taking of the same test two times.
4. Arrange test items in ascending order of difficulty.

A variation of the traditional true-false item would be to have students correct a false item. The following is an example :

Three classifications of rock are igneous, sedimentary, and limestone.

In the above named true-false item, the student would correct, if knowledgeable, the incorrect part of the test item.

A second type of teacher-written test item is the multiple choice item. In writing multiple choice items, the following criteria need to be followed :

1. Each of the distractors needs to be plausible. A ridiculous distractor can be easily eliminated by the test taker. If two ridiculous distractors are in the set of four responses, the multiple choice item really becomes a true-false item, since either one or the other response would be correct.

2. The stem of the multiple choice item together with each of the responses should make for a complete sentence, grammatically correct. For example, in the following multiple choice, one response does not harmonize grammatically with the stem

A rock classified as sedimentary is

- (a) conglomerate (c) granite
- (b) basalt (d) the cause is particles of sand and/or rock cemented together in streams and other bodies of water.

In the above multiple choice item, responses "a", "b" and "c" make a complete sentence with the stem. Response "d" is not grammatical.

3. Three responses may be utilized in a multiple choice item if a fourth plausible response cannot be written.

4. Multiple-choice items should measure what students have learned and not skill in guessing. Thus, items such as "Which of the

following is the best answer ?" may not be appropriate. In the arena of values clarification, there are no exact answers. Items emphasizing opinions should then be stated as such. For example : According to the instructor, which is the foremost cause of pollution in the United States ?

- (a) governmental policies
- (b) manufacturer's concerns.
- (c) a lack of concern by citizens in society.

If the phrase, "According to the instructor" were left out, students might guess what is wanted in terms of the desired correct response. The science teacher needs to measure what has been learned by students in ongoing units rather than guessing abilities.

5. Higher levels of cognition should be measured when utilizing multiple choice items to appraise student progress. It is relatively easy to measure vital facts that students have acquired. However, facts need to be comprehended, analyzed, utilized and appraised as to their worth in the problem solving arena.

A third kind of teacher-written test item is the essay item. Students individually need to have an adequately developed writing vocabulary in order to answer essay test items. Additional criteria in writing essay tests include :

1. Each item should be adequately delimited. The essay item "Discuss science" is much too broad. Volumes and volumes have been written on diverse academic disciplines, such as astronomy, biology, chemistry, botany, zoology, geology, physics and ecology. It certainly would not be meaningful for students to respond to an item such as "Discuss science". Toward the other end of the continuum, a factual answer to a question does not reflect content required in essay examinations. Thus, the following also is not appropriate in essay testing : Name five elements from the periodic table of elements.

Essay items require students to recall and organize content written. Sequential sentences

within a paragraph and proper sequence among paragraphs is significant. Valid subject matter must be written by the learner in relationship to the perceived problem area. Questions such as the following are appropriate to have as essay items:

How are *each* of the following rocks formed?

(a) sedimentary, (b) igneous; and (c) metamorphic

2. The mechanics of writing should be evaluated separately from content written by students. The mechanics include spelling, handwriting, punctuation, capitalization, and usage. There are science teachers who would appraise student responses only in terms of content written and not on the mechanics of writing. Both are important. Certainly, if the mechanics of writing is omitted in its appraisal, it may be difficult for the science teacher to evaluate the quality of ideas expressed. A good example here might be if too many words are misspelled or illegible handwriting is in evidence, the instructor may not be able to comprehend written content. A junior scientist should be a good communicator of subject matter orally or in writing.

3. It is a good procedure to have a colleague evaluate written products in essay writing. Thus, both appraisers may notice the degree of agreement in the final scores, ratings, or grades given. Interscorer reliability is an important concept to emphasize when subjectivity in grading is involved. With interscorer reliability, the goal is to ascertain how much agreement there is in appraisal results from the two or more evaluators involved.

A fourth type of teacher-written test item is matching. In a matching test, the following criteria need emphasizing:

1. More items need to be in one column compared to the second column. Thus, the process of elimination cannot be utilized as extensively in matching the remaining items com-

pared to if the same number of items would be in column one as compared to column two.

2. Items in a matching test should deal with a single topic only. The topic of a matching test could then be rocks and minerals, as an example. No other topics then should be stressed within this matching test. The test taker might easily match the unrelated items, column one with column two. No other sensible matching involving the unrelated items in the two columns would be possible.

3. Single concepts should be in evidence in one of the two columns. Certainly, both columns should not contain lengthy sentences. It is too complex to match column A with column B when both contain lengthy sentences.

4. The length of the test depends upon the maturity level of involved test takers. If a test is excessively lengthy, fatigue and tiredness may be an end-result of the test taker rather than concentrating on achieving well on the matching test.

A fifth type of teacher-written test item is the short answer or completion test. Adequate subject matter needs to be inherent in each test item so that the test taker knows what is wanted in terms of responses. The following lacks content:

land . . . are . . .

No student would know what is wanted in terms of correct responses. Guesswork only would be involved. The following completion item is recommendable as a model. Three states of matter are . . . , and . . .

There are three and only three answers in any sequence, which would be correct, namely liquids, solids, and gases.

Additional criteria which needs emphasis in writing short answer or completion items include:

1. Vital subject matter needs to be inherent in responses that students make in the filling in of blank spaces. Trivia items in testing should be omitted.

2 Test items should measure if students have attained relevant objectives.

3. Wording used should harmonize with present reading readiness of involved students. If the wording is excessively difficult, the completion test may measure reading achievement rather than facts, concepts, and generalizations acquired by learners.

4 Each blank space should be of equal length so that pupils do not receive clues as to which is the correct answer due to different lengths of spaces harmonizing with the length of each word wanted as correct responses. Thus, to provide clues to students as to which are the correct responses, a longer word wanted as an answer would have a longer bar within the completion test. Clues then should not be provided to students as to what is desired in an answer

Sociometric devices may be utilized to determine membership within a committee. There are numerous times when students and the science teacher will wish to stress committee endeavours in the classroom. Utilizing science experiments as learning opportunities can definitely be emphasized within a committee setting. Adequate and appropriate equipment for experiments in science should be in emphasis.

A problem can be identified within a committee involving students with teacher guidance. The identified problem ideally should relate to the ongoing science unit. After the problem has been identified, data from a variety of reference sources need securing. A hypothesis or answer to the problem is developed. The hypothesis may be tested through experimentation. After the science experiment has been completed, the original hypothesis is then modified, accepted, or refuted. Students need to remember that a hypothesis is not a fact but is subject to testing. Experiments in the science curriculum can emphasize problem solving methods stressing the complete act of thought.

Thus, within a committee framework experimentation and problem solving can be emphasized. Members within a committee can be selected through sociometric devices. The teacher then can ask students to list on paper their first, second, and third choices of individual members with whom they would wish to work on a committee. Results from the sociometric device are kept strictly confidential by the science teacher. Respondents to the sociometric method in determining committee membership need to be assured of the confidential nature of their responses. Hopefully the teacher can utilize this information in forming committee membership.

Students who are isolates need to be placed within a committee where others are highly accepting of human beings. Certainly, the isolate should not be required to work with others who have formed a rigid, clique relationship. Social development of students is significant to emphasize in the science curriculum.

In Summary

There are numerous evaluation procedures which can provide needed data pertaining to student progress in science. A variety of techniques need to be utilized to appraise student achievement in understandings, skills, and attitudes. Thus, the following approaches may be emphasized.

1. anecdotal records in providing the teacher with an overview of representative recorded behaviour of pupils
2. rating scales to notice achievement in open ended behaviours
3. checklists to determine which precise objectives of learners have been attained.
4. discussions to notice subject matter and processes acquired by students.
5. teacher-written tests to evaluate facts, concepts, as well as generalizations attained by pupils
6. sociometric devices to appraise student social development.

A Pragmatic Approach to Teach 'Processes' of Experimental Work in Physics to Pupils of Rural Schools of India

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The pupils of rural schools of India are denied practical work in Physics for several reasons, the most important of them being our content-based approach to laboratory work. A process-based approach to practical work is proposed to highlight that at school level 'Process knowledge' is more important than 'Content knowledge' and to suggest a procedure to minimise the gap between the students studying in rural schools and urban schools.

Introduction

During the period of renaissance, the rise of physics was largely due to Galileo's reliance purely on experimental methods and not on Aristotelian logic. Since then experiments have been the main tool of science in converting hypothesis to theory, modifying old concepts,

helping the formation of new concepts and opening new avenues with startling new results. All these experimental work can be grouped into four domains (Dixon and Holster 1984).

- (a) *Observation* : In this category the experimenter has no means of controlling objects of his interest. This happens in the field of astronomy. Perhaps the greatest theory outside astronomy and based exclusively on observation is Darwin's theory of evolution.
- (b) *Cognition* : Here the experimenter is concerned mostly with such types of queries as—"Let us explore what will happen if" Examples under this category are the famous 'Thought Experiments' of Einstein.
- (c) *Exploration* : It is the type of experiment which one can conduct on objects with which one has contact but has limited control. A good example is the early work of anatomists attempting, by dissection, to comprehend the working mechanism of living things.
- (d) *Investigation* : Controlled experiment, conducted for specific purpose, in any laboratory comes under this category.

Realising the utility of laboratory work for the growth of science, John Dewey derived, at the turn of this century, the position experimental work should occupy in the curriculum. But at a meeting of the rural science teachers at Ascom Bryan College near York, U K., in June 1985, a point was made (Pitt 1985) that—"Little *real experiment work* was taking place in many secondary school science departments". Thus there is a gap between the objectives set forward by John Dewey and what is being practised now in schools in general and rural schools in particular. In this paper we try to propose a new-look remedial measure for this.

Keeping in view the comments presented in the above meeting, one concludes that at present the experiments that are conducted in the schools are either to

(i) repeat past discoveries where the answers are known, or

(ii) determine some known physical properties of matter/energy. The pupils are told in detail what they should do/discover and then they spend their time in performing the experiments. This age old procedure raises several questions in two phases.

Phase I. Academic questions (Bard 1978).

- (1) Will not the setting down of a too detailed 'Requirement' for the pupils to follow, cramp his spirit of investigation?
- (2) In the teaching of laboratory work should the emphasis be on doing or on learning?
- (3) Is it not necessary to keep an objectively analytic attitude towards experimenting?

Phase II : Questions relating physical facilities

- (1) Since most of the experiments in Physics now spelled out in the curriculum need sophisticated instruments, should the pupils of rural schools (particularly in India) be deprived of laboratory work due to lack of facilities?
- (2) If not, then, is there a way out?

Answers to both the sets of questions concern the pupils in the rural schools where answers to the first set of questions affect pupils in the urban schools where some laboratory facilities are available.

A New-look Procedure

As an answer to the first question under Phase I, it is more and more felt that guidance

should be precise enough to give the pupil a clear picture of the task, but not so prescriptive that he/she is merely following a recipe without any room for initiative. The answer to the last two questions in Phase I is contained in the statement by Poincare (in Kelley 1941) that,

—Science is built up with facts as house is with stones, but a collection of facts is no more a science than a heap of stones a house —

This philosophy is strengthened by the comment (Roller 1970, Good et al. 1985)—

—Science is the quest for knowledge and not the knowledge itself.—

Keeping the spirit of these ideologies in view, one should then do away with the existing Content-Based-Practical-Work (CBPW), where the pupil is asked to go through the ritual of mechanically performing a set of experiments (Bond et al 1978). And one should have Process-Based-Laboratory-Experiences (PBLE), where the pupil will have a greater scope to learn some of the objectives (Hellingman 1982) of laboratory work

As regards the questions under Phase II, it is a fact that the pupils of rural schools of India have been deprived of any laboratory work in Physics due to lack of facilities and this is not a good trend for the growth of Science Education. Over the years, the only suggested solution to this drawback has been improvisation of equipments for conducting experiments in rural schools. But in practice the proposal has to remain a still-born one. This has been so because of our (i) obsession with CBPW, and (ii) search for improvisation to conduct these experiments. As for example, one of the common school-level experiments is the measurement of the velocity of sound in air. If no resonating tube is available then the suggested improvisation is to make a resonating tube by using a fused fluorescent tube and conduct the experiment. Such an ingenious

suggestion appears quite feasible in its bare form. But are any fused fluorescent tubes available in villages? It is thus clear that such innovative improvisations are not going to serve any real purpose. Thus for a solution to this problem one has to totally change one's approach towards laboratory work in schools.

In this new-look procedure we suggest the following objectives for practical work in Physics in schools

- (i) Let the aim of the laboratory work be to learn certain 'Processes' and not performing a few monotonous manipulations with sophisticated instruments
- (ii) Let CBPW be replaced by PBLE so as to highlight some of the 'Processes'
- (iii) Let innovations which will help these PBLE be encouraged.

This pragmatic approach towards practical work in physics will (a) do away with sophisticated equipment, (b) need very little space, and (c) yet expose the pupil of even rural schools to laboratory methods and processes

A check-list of the broad 'Processes' a pupil may be expected to learn and appreciate through these PBLE in Physics is the following (Hellngman 1982)

- (a) Observation : (1) Qualitative
(2) Quantitative
- (b) Analysis of : (1) Qualitative data
(2) Quantitative data
 - (i) Identifying and selecting variables
 - (ii) Calculation
 - (iii) Drawing graphs
- (c) Manipulative skills
- (d) Experimental design
- (e) Minimisation of error
- (f) Precautions
- (g) Hypothesis making and testing

As an example, we consider the following PBLE which a pupil can have and learn some of the above processes

Let a sheet of paper of the size of a writing pad be released from a height and allowed to fall freely to the ground. Then another piece of the same paper may be taken, crumpled into a ball and the ball may be released from approximately the same height. These two operations may be repeated a few times in front of the whole class. Then the pupils may be asked ;

- (1) Do you find any difference in the two free fall experiments ?
- (2) Although in both the cases, pieces of paper of the same type and size were involved, why is there a difference in times of the two free falls ?

The first question will try to highlight their capability of qualitative observation whereas the second question will lead them to the process of analysis of qualitative data and proposition of a hypothesis. The teacher will here act as the controller of their thought process. Eventually the suggestion will come that because of the difference in their shapes i.e. areas (effective), there is a difference in their times of free fall from a given height. Thus they will not only propose a hypothesis but will be able to learn the process of identifying the variables. Here the teacher has to lead them further by asking :

Is there any other variable in this experiment?

They may fail to answer this question. Then the teacher may produce a cardboard of the same size as the paper and repeat the experiment. Obviously the pupils will immediately respond that the mass of the paper is the other variable. At this stage they may also be taught, out of the three i.e. area of the paper, mass of the paper and time of free fall, which one is an independent variable and which one is a dependent variable.

These operations will not only arouse the curiosity of the pupils but also through them the pupils are gradually made cognizant of the process that "Science is product of fluid enquiry and is made of investigations which rest on conceptual innovations" (Schwab 1962).

Now the class may be divided into two groups. One group may be asked to find out how the time of free fall changes with change of area (mass remaining constant) and the other group may be asked to determine how the time of free fall changes with the change of mass (area remaining constant). This step will teach them about what is conventionally called "design of an experiment" Because they have to plan out a process by which one variable is suitably kept constant throughout the experiment. They may take some time to arrive at the right solution, but the time spent for this is worth it. To minimise the time spent on this the teacher may carefully guide them by asking small questions and dropping in small suggestions. Here again the teacher acts as the controller only and not as a source of knowledge from whom every information flows out.

Once the design of the experiment is approved by the teacher he may then ask the pupils :

- (1) For a given height how will the time of free fall change with the change of area (mass remains constant)?
- (2) For a given height how will the time of free fall change with the change of mass (area remains constant)?

The pupils will come out with various replies. The teacher may note them down on the black-board, stating that they are hypotheses and need testing.

The pupils may then be asked to perform the experiment, using a wrist-watch and the

quantitative data may be recorded. Argument may be advanced that the wrist-watch may not be an accurate instrument for measuring time in this experiment. However, we must keep in mind that our emphasis at this school level is more on learning the processes than on accuracy of the measurements. If we put more stress on accuracy then it may have an adverse effect on our very objective of PBLE.

After a set of data has been obtained, the hypothesis may be tested. Then they may be asked to draw graphs of area \sim time and mass \sim time. This will teach them the processes involved in drawing the graphs, like, choosing the axes, choosing a scale, drawing the graph, interpreting the graph, and drawing conclusions from the graph. Even a step further may be taken in asking them to find out a law by drawing a graph of area \sim 1/time.

At the end, the difficulties faced by the pupils in performing the experiments and how to minimise the errors may be discussed.

Conclusion

In conclusion, we note that we need for its successful operation only sheets of paper and a wrist watch, which will be available in all schools, even in rural ones. Further, it is demonstrated that through this pragmatic approach, the PBLE

- (1) aims at teaching the pupils most of the 'Processes' involved in the laboratory work in physics,
- (2) has the scope to arouse the curiosity of the pupils,
- (3) does away with the conventional CBPW,
- (4) does away with sophisticated equipments,
- (5) can be easily incorporated in the curriculum,

- (6) can be performed by pupils in rural schools, and
- (7) needs no financial commitment.

All that this new-look procedure needs is that the educationists, curriculum framers, and teachers should cease to become conformists with respect to CBPW. Moreover, the teacher

should be the controller of these PBLE and not a didactic. Then only a list of PBLE can be prepared and successfully executed for science teaching at the school level with the sole aim of elevating the 'process knowledge' of the pupil. It will also help to bridge the now existing knowledge gap between the pupils of the rural schools and those of the urban schools.

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Observation as a Part of Scientific Method

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Science is a process of inquiry that ferrets out relationships existing in nature. On the basis of this discussion it can be said that if science is man's endeavour to inquire, analyse and describe the universe, then inference is that facts, laws and principles ; the content of science exists in nature and the role of scientist is to inquire

Science and Scientific Method

Einstein (1940) defined science as "the attempt to make the chaotic diversity of our sense experience correspond to a logically uniform system of thought". Gore (1978) said, "Science is the interpretation of nature and man is the interpreter". In connection with the scientific phenomenon Shamos (1960) has said, "..... science is a collection of facts and the practice of science as little more than the routine accumulation of minutiae". Samos further says, "It is time that science

deals with hard, inflexible facts, but it has also to do very general ideas and abstract principles ; and it is the coordination on these ideas and observed facts that it is the essence of modern science" Actually science is the human endeavour that seeks to describe with ever increasing accuracy, the events and circumstances that occur or exist within our natural environment. The accuracy of the description of phenomenon depends upon the informations observed or gathered about this phenomenon, and the inter-relationships between its parts and other phenomena. Each generation develops what it considers to be satisfactory descriptions of the natural phenomena that it recognizes. Thus science is a self-correcting and self-generating human endeavour, but it is basically an intellectual activity and its products are the intellectual representation of the natural phenomena. Science is a process of inquiry that ferrets out relationships existing in nature. On the basis of this discussion it can be said that if science is man's endeavour to inquire, analyse and describe the universe, then inference is that facts, laws and principles , the content of science exists in nature and the role of scientist is to inquire.

Science is more a verb than a noun, because a scientist works rather than what science is. Science is more concerned with the process by which a body of reliable knowledge is obtained than with the resulting body of knowledge itself. Thus science deals about the ways in which scientists seek concepts. These ways are collectively known as scientific method. Bridgman (1950) said, "The scientific method, as far as it is a method, is nothing more than doing one's damnest with one's mind, no holds barred". According to Bridgman (1949), "Scientific method is what working scientists do, not what other people or even they themselves may ask about it ... The working scientist is too much concerned with getting down to brass tacks to be willing to spend his time on generalizations". If science is what scientists do, then there are as many scientific methods as there as individual scientists. A

scientific method carries well-defined and clear steps. All the steps together give objectivity to the science which is often thought to be the essence of scientific method. Generally a scientific method possesses the following steps -

- Problem
- Hypotheses
- Collection of information/facts
- Analysing the facts to test the hypotheses
- Generalization

Observation is a method of collecting information or facts and is treated as a scientific procedure because it deals with the direct relationship between observer and observed.

Observation Defined

Hutt and Hutt (1974) have not given the definition of observation in their book "Direct Observation and Measurement of Behaviour". Von Cranach and Frenz (1969) have avoided an explicit definition, but have pointed out the characteristics of observation in their text. According to dictionary the word 'observation' has a meaning of, "the act or practice of noting and recording facts and events as for some scientific study". It is the process of watching and noting the phenomena accurately as they occur in nature with regards to mutual relations of cause and effect. Good (1969) defined observation as, "the act or process of observing (usually complex) conditions or activities as a means of gathering descriptive or quantitative data". Young (1961) says, "observation is a deliberate study through eye" Actually in the process of observation the observer not only sees and collects information but he/she uses other senses also.

A very comprehensive definition of observation is given by Weick (1968). He writes, "An observational method is defined as the selection, provocation, recording and encoding

of that set of behaviours and settings concerning organisms 'in situ' which is consistent with empirical aims". In this definition the used technical words are explained by Weick as follows :

- selection refers to decisions made by the observer before, during and after observation.
- provocation refers to the subtle changes made in the natural environment to increase the clarity of the results, without destroying the behavioural content.
- recording of behaviour refers to the raw notes of events
- encoding of behaviour refers to the simplification of records by means of ratings, categories of frequency counts.
- the word 'set' is not used in the set theory, but it emphasizes that most observational studies use more than one behavioural measures and that these multiple measures are often obtained in different situations.
- 'in situ' means this method is typically used to gain data in the subjects' normal environment.
- empirical aims indicate that hypotheses can be tested or formulated and descriptions made by means of observation.

Observation and Scientific Method

Conant has developed a series of conceptual schemes arising out of observation and experiment, and giving rise to further observation and experiment. Scientific method means all the operations, procedures, devices and types of processes by which scientists arrive at the conceptual schemes. These include observation, experiment, the educated guess, the chance diversity, the library research, trial and error, common sense, verifying hypotheses and many others.

Pinther (1972) said observation as a scientific method, because it has an aim, a limit on the amount of information to be collected, results stable overtime and replicable; planned observation session; and finally objective observation and analysis. Wright (1960) says, "research methods that leave nature and society to their own devices, rest upon direct observation as a specific practice that includes observing and associated recording and analysis of naturally occurring events and things".

Observation involves three phenomena sensation, attention and perception. Sensation is done by sense organs. The exactness and accuracy of observation is dependent on the power and sensitivity of sensory organs like, eyes, ears, nose etc. Attention is related with the ability of concentrating on the subject matter of the study. Perception enables the mind to recognize the facts by identifying sensations and drawing upon experience and introspection. Thus on the basis of these three phenomena included in the process of observation, it can be concluded that observation is:

- (i) seeing or receiving objects/processes with a purpose,
- (ii) collecting the facts on the basis of direct knowledge of the investigators/observers,
- (iii) the perception with a purpose,
- (iv) regulated perception, and
- (v) acquiring knowledge through the use of sense organs.

Observation is a concrete idea, often consisting of many simple conceptions combined in a single statement. To observe something is to direct one's senses and perceptive powers to objects, events, or circumstances. Nature can be studied only through the senses, and science is fundamentally concerned with exploring and interpreting the physical world

through the three fundamental areas of physics, chemistry and biology. Science is a way of describing and explaining some aspects of world around us. Thus, people can study only the model of nature that the senses and the human mind enable them to construct. Although science can establish criteria by which to determine the reality of objects of the thought, science cannot test the validity of the criteria themselves. So long as science remains empirical, it cannot test the truth or falsity of reality or concepts of existence. Thus, there is no proof that any model of nature, consistent though it may be, represents truly the real structure of nature.

How is Observation a Scientific Procedure ?

Following merits of observational method for gathering information show this method as a scientific procedure :

- (i) Observation is a direct and natural way of data gathering device
- (ii) Data collected through observational methods are more real, accurate and true.
- (iii) Observation is a more refined and scientific technique
- (iv) All items of observation are ironed out in the preliminary trials of the technique. Thus the phenomenon is properly dissected beforehand and its significance aspects are correctly identified.
- (v) Observational methods do provide access to such information which cannot be obtained through any other method.
- (vi) Observation is the best method to get quantitative data
- (vii) In social sciences particularly social, political, economic, cultural status cannot be studied by using quantita-

tive techniques. In such cases observation may be the right technique of study

- (viii) Helmstadter (1970) says, "The major advantage of observational approach is its directness. It avoids necessity of dealing with hypothetical constructs inferred from behaviour and works directly with the behaviour itself. If done carefully, there is less need to worry about the problem of conscious taking or unconsciously protecting one's ego in responding to direct question. It is especially useful for getting such things as judgement in choosing companions, aesthetic appreciations and cooperation".

The Process of Observation

Nanlin has called five sequential steps which are involved in the process of observation. These steps are: preparation and planning; entering the environment of investigation; initial interaction; observation and recording; and termination of the field work. These steps are given in the following paragraphs.

(i) Preparation and Planning

This step answers the questions like what, when, where and how to observe the process events/behaviours. Here the observer decides the types of observation (participant, controlled, uncontrolled etc.) Before observation, the observer or investigator should be well familiar with the events or processes to be observed.

(ii) Entering the Environment of Investigation

In this stage the observer enters the environment where he/she has to observe the events/processes.

(iii) Initial Interaction

After entering the environment of investigation the observer should present his/her posi-

tion as participant or non-participant and accordingly establish rapport with the environment.

(iv) Observation and Recording

The recording can be done as soon as the events occur. Observation and recording both are simultaneous processes and when the observer is recording he/she must be attentive towards events/processes. In some cases observers are trained to memorize the events and record these events when there is break in the action. Observer should note the events in key words to keep the details from slipping from his memory. Such activity should be in an unobstructive manner. Blind recording of behaviour should be avoided.

(v) Termination of Field Work

The termination of field work involves the termination of research rapport with the environment developed during the study.

Conclusion

As it is discussed in the above paragraphs, scientific method is the best suited method to study the environment and generalize some pattern of the environmental factors or variables as well as to establish relationships among environmental phenomena. The heart of the scientific method is the accurate and valid data gathered during the study. Observation is the most scientific technique to get accurate and valid data, because there is nothing between observer/investigator and observed. There is a direct relationship between investigator and events/processes/behaviours to be studied. Thus it can be said that by using observational technique investigator gets first hand experience. Observation can be used to gather information in physical sciences, biological science and in social sciences as well as in other branches of study where there is a need of having first hand experience.

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An Evaluative Study of the Teaching Efficiency of Prospective Biological Science Teachers

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Internship is certainly a more comprehensive concept and its introduction in teacher education is aimed at enlarging the scope of experiences needed to prepare a more competent teacher. It is also envisaged that such experiences in realistic situations would facilitate, if not accelerate, the process of socialisation of a teacher and minimize the time, energy and efforts spent in on-the-job learning.

"A sound programme of professional education of teachers is essential for the qualitative improvement of education. Investment in teacher education can yield very rich dividends because the financial resources required are small when measured against the resulting improvements in the education of millions."

—Education Commission, 1964-66.

Introduction

The training of student-teachers is carried out at present under two nomenclatures, i.e., practice teaching and internship. Nevertheless, there is little evidence to show any qualitative difference between the two. Internship is certainly a more comprehensive concept and its introduction in teacher education is aimed at enlarging the scope of experiences needed to prepare a more competent teacher. It is also envisaged that such experiences in realistic situations would facilitate, if not accelerate, the process of socialisation of a teacher and minimize the time, energy and efforts spent in on-the-job learning. However, in actual practice except in a very few cases, internship programmes have hardly gone beyond what is being done under practice teaching. Since a strong recommendation has been made for developing a task-oriented teacher education system, it is imperative that practice teaching should be more realistic and suited to the actual classroom situation. It would be to our definite advantage if student teachers are put through a series of simulating situations before they are pushed into an actual classroom. It is reasonable to believe that such student teachers would be in a better position to handle the real classroom situation.

Need and Objective of the Study

One of the major objectives of teacher education programmes is to prepare efficient teachers. Prospective teachers participate in practice teaching besides learning the subjects theoretically. Practice teaching plays a major role in the Colleges of Education to identify the merits and drawbacks of the teaching procedure of prospective teachers and to give further suggestions to improve their teaching.

Methodology

The Lesson Assessment Schedule which is being followed by the Practical Examiners of the Nagarjuna University is adapted to assess

TABLE I
Lesson Assessment Schedule

<i>Factors</i>	<i>Notes of Lesson</i>	<i>Personality, Appearance, Manners, Pronunciation, Language, Discipline, etc.</i>	<i>Introduction, Presentation, Exposition, Recapitulation, etc.</i>	<i>Aids to Presentation, Questioning, Illustrations, Blackboard Work, etc</i>	<i>General Impression</i>	<i>Total Marks</i>
Max. Marks	5	10	15	15	5	50
Marks Obtained	—	—	—	—	—	—

the teaching efficiency of prospective biological science teachers. **Results and Discussion**

With the help of the Lesson Assessment Schedule, the investigator has assessed sixty lessons of the prospective biological science teachers assigned to him as they are for the purpose of practice teaching in Rayapati Venkata Ranga Rao College of Education, Guntur, Andhra Pradesh

Each factor is awarded marks according to the performance of the teachers for each lesson. The total marks for each factor are converted into aggregates. The aggregates thus arrived are presented in the following table.

1. Regarding the preparation of the notes of lesson, the prospective teachers are average. Care should be taken in preparing the lesson plans by the prospective teachers because it includes the working philosophy of the teacher, his information about and understanding of his pupils, his comprehension of the objectives of education, his knowledge of the material to be taught and his ability to utilise effective methods

2. The second factor includes the teacher's personality, appearance, manners, pronuncia-

TABLE II
Aggregate Marks of Teaching Factors

<i>Factors</i>	<i>Notes of Lesson</i>	<i>Personality, Appearance, Manners, Pronunciation, Language, Discipline, etc.</i>	<i>Introduction, Presentation, Exposition, Recapitulation, etc</i>	<i>Aids to Presentation, Questioning, Illustrations, Blackboard Work, etc</i>	<i>General Impressions</i>	<i>Total Marks</i>
Max. Marks	5	10	15	15	5	50
Marks Obtained						
Total Lessons (60)	2.4	7.5	9.22	9.6	2.48	30.85
Female (37)	2.54	7.5	9.84	10.27	2.78	33.49
Male (23)	2.17	6.57	8.22	8.52	2	26.61

Figures against the samples are aggregate marks to each factor.
Figures in the parenthesis are number of lessons assessed.

tion, language, maintenance of discipline in the classroom, etc. As far as this factor is concerned, the prospective biological science teachers are better in this category. Teachers are poor in maintaining discipline in the classroom which deserves further attention.

3. The third factor includes the methodology of teaching a lesson. In this aspect, the prospective teachers' are not so much competent in teaching a lesson. Attention should be paid to teach the lesson systematically because teaching is the purpose of educating individuals.

4. Regarding the educational technology, i.e., Aids, Questioning, Illustrations, Blackboard work, the prospective science teachers are average. It is a well known fact that no wise science teacher can ignore the use of teaching aids in order to make his lesson more interesting and realistic because it is an admitted fact that we learn through senses and the senses of sight and hearing have an important role in this process. Hence the science teachers should use the audio-visual aids to revolutionise the other methods of teaching. At the same time the teachers should put such questions which stimulate interest among students for further learning.

5. On the whole, the performance of the biological science teachers is satisfactory. The teachers have to improve their teaching efficiency to make their lessons effective and interesting.

6. Women teachers are more efficient than men teachers. This supports the previous investigations and opinions of many educationists. So preference as far as possible

should be given to women candidates in teaching profession.

Suggestions

1. Lesson Plan is known as a plan of action. So teacher educators have to train the prospective teachers in preparing the lesson plans perfectly in order to achieve the objectives of the lesson on hand.

2. Prospective teachers have to explain to the students about the need and applicability of the lesson.

3. Prospective teachers have to create a democratic situation in the classroom in order to involve the pupils in teaching learning process actively.

4. Proper classroom discipline should be maintained to avoid the misbehaviour of the pupils.

5. Prospective teachers have to present the lesson after preparing the pupils to receive the new knowledge through proper introduction and motivation.

6. Herbartian steps have to be followed in presenting the lesson by the teachers.

7. Teachers have to use the audio-visual aids in order to involve as many senses as possible. Improvised and teacher-made simple aids will be more effective in teaching. Pupils can also be asked to prepare aids.

8. Questioning occupies a major role in improving the capacity of understanding memory and pupil participation.

9. Blackboard summary along with diagrams should be developed for easy understanding and for revision purpose.

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An Integrated Science Curriculum Centred Around Bicycle

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In this light, the science curriculum should be such that it should avoid stuffing the minds of children with facts and information but sharpen and quicken their senses to enable them to explore their own environment. In other words, the curriculum should consist of functional science education geared to life. It should be related to technological, social and environmental problems

The Need

Impact of science and technology has reached even the remotest parts of the world. The social life, economic system and politics are all influenced by science and its achievements. In a way, science and technology have become all pervasive.

Moreover, all the formal school subjects are also being made scientific by making use of scientific processes like experimental design, model construction, making observations,

collection of data and drawing conclusions. Therefore, it becomes the prime aim of school education to provide suitable opportunities and situations for the functional scientific literacy to all the children.

In this light, the science curriculum should be such that it should avoid stuffing the minds of children with facts and information but sharpen and quicken their senses to enable them to explore their own environment. In other words, the curriculum should consist of functional science education geared to life. It should be related to technological, social and environmental problems.

The Purpose

The science curriculum should include activities involving handwork and learning skills leading to co-ordination between mind and hand. It should develop healthy attitude towards labour and manual work. An integrated science curriculum is a must to lay sound attitudinal foundations towards manual work. It must conform to the conditions, materials and machines in the immediate environment of the child. In order to achieve this aim of the science curriculum, the proposed activities should have direct relation to certain scientific and technological processes. The activities should also sharpen the vocational skills of the students and give them the feel of the principles, operations, structures and processes involved in the implementation of a work situation. Working with simple tools, involving repairs and construction, always leads to the development of an attitude of dignity of labour and manual work. It also induces an awareness regarding personal and environmental hygiene.

Proposed Curriculum

An attempt has been made to develop a functional science curriculum encompassing the areas of varied subjects. The curriculum is meant for 14+ students of rural areas and small towns. The curriculum revolves around a simple and common machine—the bicycle.

The proposed curriculum integrates the areas of subjects like physics, chemistry, biology, civics, sports and recreation, low level technology, manual skills, vocational and work experience and history. The topics of study and work experience are as follows :

Physics

1. Linear motion : uniform, non-uniform motion ; displacement, speed, velocity ; acceleration.
2. Kinds of motion : Newton's three laws of motion ; momentum ; inertia
3. Lever : kinds ; gears ; cog-wheel ; mechanical advantage ; efficiency ; transformation of energy
4. Friction : uses and abuses ; methods of reducing friction ; laws of friction
5. Circular motion . centrifugal force ; leaning of bicycle on curves ; moment of inertia.
6. Sound : cycle bell ; pitch, loudness ; quality.
7. Electricity : cycle dynamo , laws of electro-magnetic induction
8. Light : reflection ; mirrors.
9. Air pressure : Boyle's law ; Pascal's law.
10. Thermal expansion : expansion of gases and solids, applications of thermal expansion.

Chemistry

1. Physical and chemical changes.
2. Steel and iron : manufacture and properties.
3. Paints : chemical composition of paints
4. Rusting : causes and prevention.

5. Electroplating.
6. Rubber.
7. Adhesives.
8. Plastics

Biology, Sports and Recreation

1. Human physiology.
2. Cycle races
3. Cycle polo
4. Cycling expedition
5. Cycle tricks and jugglery.

Low Level Technology

1. Cycle-rickshaw
2. Cycle wheel-barrow.
3. Cycle ambulance.
4. Cycle blower
5. Cycle grinding wheel
6. Cycle spinning wheel.

Manual Skills

1. Cycle fixing and dismantling
2. Cycle repairs.
3. Use of hand-tools.

Social Sciences

1. Traffic rules
2. Upkeep of cycle.
3. Discovery and history of the wheel.
4. Invention and history of bicycle.
5. Visit to a bicycle factory.
6. Visit to a bicycle dealer.

Flavour Course Trial

The author implemented a six week flavour course based on the proposed curriculum in

the lesson periods meant for the Socially Useful Productive Work (SUPW) as the permission for the full term course was not given by the school authorities. Each lesson period lasted 40 minutes and was held every day for six weeks for the academic session 1984-85.

The two sections of Class VIII consisting of 70 students of Navodaya Vidyalaya, Kunga Kothi, where the author was employed in 1986, underwent the course. The student reactions to the course were highly positive and they enjoyed learning through the integrated approach. For the flavour course one topic for each of the subject areas was taken up. All the students unanimously agreed to for more courses of this kind centred around various simple machines.

Justification

The proposed curriculum is relevant to the actual life situations of children in the rural

areas and small towns, and can be implemented easily without any difficulty. Perhaps, the curriculum could make children think technologically. They are quite likely to come up with new suggestions about the uses to which bicycle can be put.

Science for children is a way of gathering experiences. Any work or play which is concerned with exploration, investigation and working with hands, will interest them. The direct experiences evoke questions and deeper inquiries. And questions asked by children lead to further investigations and activities. Moreover, experiences indoors and outdoors always lead to all sorts of activities like counting, measuring, timing, estimating, predicting, constructing, observing and modelling, etc. An integrated science curriculum incorporating direct experiences and activities can make science education functional and geared to life.

Some Elements of Environmental Education

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It is being widely felt that Environmental Education should form an essential component of education at every stage, may it be primary, secondary or tertiary. Moreover, it is also an undisputed fact that its form and component shall be different in different contexts (Unesco 1977) Programmes, their objectives and forms shall be different for youth, scientists, non-formal system of education, and at primary level.

Introduction

Since the historical event of Conference on Human Environment at Stockholm, Sweden in 1972, resulting in the establishment of United Nation Environmental Programme (UNEP) and Unesco launching the International Environmental Education Programme (IEEP), a lot has been done¹ and is currently being done to promote Environmental Education (EE) in India and abroad. It is being widely felt that Environmental Education should form an essential component of education at every stage, may it be primary, secondary or tertiary. Moreover, it is also an undis-

puted fact that its form and component shall be different in different contexts² (Unesco 1977) Programmes, their objectives and forms shall be different for youth, scientists, non-formal system of education, and at primary level.

At the school level, the context of environment is related in two ways : the environmental education³ and environmental approach⁴ of teaching. The latter has been used and found to increase the environmental awareness of the children. However, EE is more wide and more deeply related with the education about the environment, its management. In India, EE is still not the part of school education to the desired extent and it is still to be thought and discussed what can be the best possible means for this. The two common proposals in this connection are : 1. Making it a separate discipline and 2. Integrating it in the diffused form with the existing curriculum. Whatever may be the mode of imparting EE, some core concepts can be identified and a strategy for developing these concepts can be discussed. Here we take some of the important concepts of primary level pertaining to EE and discuss the various activities and strategies which can be adopted in the classroom. However, no mention of the class is being made in view of the fact that these can be modified according to the 'environmental' needs of the class.

Concepts and Activities

Some of the major concepts pertaining to EE which can be taken up at primary level are :

- (a) Man is dispensable.
- (b) Flora is indispensable.
- (c) Water and oxygen are most important for life.
- (d) Water is contaminated in many ways.
- (e) Air is contaminated in many ways.
- (f) Various components of environment are interdependent.
- (g) Noise is harmful.

The list is not exhaustive. Other concepts can also be taken up on similar lines.

(a) *Man is dispensable*

Concept Things on earth are not 'man-centred', though sometimes it may appear so due to biased projection. The earth and the life on it will continue without difficulty if there were no man on it. Animals and plants do not need men for their survival. They can do of their own.

Activities : (1) Showing the landscapes scenery without men and conducting the discussion. Topics such as 'can this survive without external interference?', 'What are its needs?' can be taken.

(2) Creative ideas on topics such as 'If men disappear from earth', 'Life without men' may be discussed. Students may be encouraged to prepare write-ups, poems, drawings, etc., on such topics.

(b) *Flora is indispensable*

Concept : Man depends on flora in two ways, directly and indirectly. It depends directly for its food, medicines, fuel, clothes and many other ways. Indirectly, flora is responsible for cleaning the air, rain, as food of animals which make men's food. If there is no vegetation on earth, men cannot survive. They are a basic necessity of life on the earth. Hence their importance.

Activities : (1) Listing the ways in which plants are useful to us.

(2) Collecting the drawings, photographs showing our dependence on plants and exhibiting them.

(3) Asking students to tell the ways they depend on plants and how can we protect and increase the vegetation. Implementing these wherever this is possible.

(c) *Water and oxygen are most important for life*

Concept : If we are to name two substances which are most important for life, water and oxygen are such substances. We cannot live without oxygen for a few minutes and without water for a few days. This is the reason for their importance. Not only we but life in general is also heavily dependent on them. It is, therefore, our duty to save it as much as possible.

Activities (1) Listing the uses of water in daily life.

(2) Conducting activities showing that oxygen is necessary for animal life and the process of burning.

(3) Importance of rivers and lakes can be discussed and depicted.

(4) Studying the major water sources in the map and their effect on the concentration of population.

(5) 'How can we save water?' may be discussed in the class.

(6) 'If the store of oxygen dwindles' may be discussed in the class.

(7) The uses of oxygen may be depicted in a creative way.

(d) *Water is contaminated in many ways*

Concept : The water from the common source, may it be a river, pond, lake or well, is not normally free from bacteria and harmful impurities. The clean looking water may also be contaminated. The pollution of water is done in many ways knowingly and unknowingly. This is to be reduced in view of importance of water for our life and other animals.

(1) Taking children to the nearby river/lake/pond and discussion on ways it is being polluted. How these are harmful to us may also be discussed.

(2) Children may think of methods to stop the pollution of water.

(3) Children may make drawings showing the situations in which water is polluted. They may also make some drawings instructing what should be avoided. These drawings may be exhibited to all the children of the school.

(4) Children may collect water from 'ordinary' source and purify it to make it potable.

(5) Children may identify the agencies which regularly pollute the nearby water source and decide what can be done about it.

(6) The common harms caused by polluted water may be listed/depicted.

(e) Air is contaminated in many ways

Concept : Although there is a vast amount of air in nature we are polluting it every day in many ways and thus making life miserable. The methods of purifying air are limited in nature. It heavily depends on trees for removing carbon di-oxide. Since the number of trees is also decreasing, pollution takes a greater significance.

Activities : (1) The ways in which air is polluted may be identified. Newspaper and periodical cuttings can be exhibited to show the effect.

(2) Experiences in the heavily industrialized area and in 'open' area may be compared. 'Why do we feel uneasy at one place?' may be elaborated by the children.

(3) 'What can be the methods to avoid air pollution?' How far these can be implemented and similar questions may be discussed.

(4) Importance of trees in purifying air, their decreasing number and our role in this connection may be brought home through facts, diagrams, discussion. This may be implemented to some extent by encouraging students to plant trees and nurse them till they become 'independent'.

(f) Various components of environment are interdependent

Concept : Various components of environment, physical and social, are not independent but heavily dependent on each other. In the physical environment, the trees, the rivers, the soil and others are affected by our activities and in turn affect us, completing the cycle. Similarly, in the social environment, we depend on doctor, teacher, shopkeeper, milkman, postman and many others. In turn they depend on us for some of their needs. Thus none of the component is really independent; we should keep this in mind in managing our day-to-day affairs.

Activities : (1) Identifying the chains in the environment and analysing the interdependence of their elements. Depiction of such chains.

(2) Identifying the roles in the social environment, such as sweeper, washerman, farmer and analysing the persons on whom they depend.

(3) Imagination of the situations produced if suddenly all the farmers/postmen/teachers disappeared.

(g) Noise is harmful

Concept : Noise not only disturbs the pace of work, it also affects our health. Excess noise may result in headache, high blood pressure, mental tension, loss of capacity for concentration, loss of hearing power and many other effects. Many a times, it is possible for us to reduce the noise level created by our activities. There is need for social control in this regard.

Activities : (1) Identifying the sources of noises and classifying them as avoidable and non-avoidable.

(2) Discussion on 'law to reduce noise in our surroundings'.

(3) Decision on the 'Norms of social behaviour for reducing noise level' by the class as a result of discussion.

(4) Depiction of the scenes showing the inconveniences and problems caused to the people by noise

(5) Visit to a noisy place and collecting children's reaction.

Evaluation

Every activity and programme is to be evaluated in the light of its objectives. Similar evaluation is desirable in the context of activities suggested here and on the basis of feed-

back the activities may be improved, modified or discarded. For a more meaningful and objective evaluation, the objectives of the particular activity may be decided earlier and usefulness of the activity may also be checked before taking up the activity. Further evaluation may be done when the activity is over. Sometimes taking up the reactions of the students may also prove useful in the modification of the activity and evaluation

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On Summation of Powers of First 'n' Natural Numbers

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Introduction

The summation of first 'n' natural numbers up to cube has been worked out in textbooks. If S_1, S_2, S_3 denote the sum of the first 'n' natural numbers the square and cubes of the first 'n' natural numbers respectively, the formulae are :

$$S_1 = \frac{n(n+1)}{2}, S_2 = \frac{n(n+1)(2n+1)}{6},$$

$$S_3 = \frac{n^2(n+1)^2}{4}.$$

In this paper, an attempt is made to find the sum of the fourth powers of the first 'n' natural numbers (S_4) by two different methods.

First Method to Find Σn^4

Let us consider

$$(x+1)^5 - x^5 = 5x^4 + 10x^3 + 10x^2 + 5x + 1$$

Putting $x=1, 2, 3 \dots n$ and adding, we get

$$(n+1)^5 - 1 = 5 \Sigma x^4 + 10 \Sigma x^3 + 10 \Sigma x^2 + 5 \Sigma x + n$$

$$\text{or, } (n+1)^5 - 1 = 5S_4 + 10S_3 + 10S_2 + 5S_1 + n$$

$$\text{or, } 5S_4 = (n+1)^5 - 10S_3 - 10S_2 - 5S_1 - n - 1$$

$$\begin{aligned} \text{or, } 5S_4 &= (n+1)^5 - \frac{10n^2(n+1)^2}{4} \\ &\quad - \frac{10n(n+1)(2n+1)}{6} - \frac{5n(n+1)}{2} - (n+1) \\ &\quad (n+1) \left[(n+1)^4 - \frac{5n^2(n+1)}{2} \right. \\ &\quad \left. - \frac{10n(2n+1)}{6} - \frac{5n}{2} - 1 \right] \end{aligned}$$

$$\begin{aligned} \text{or } 5S_4 &= \frac{(n+1)}{6} [6n + 24n^3 + 36n^2 + 24n + 6 \\ &\quad - 15n^3 - 20n^2 - 15n^2 - 10n \\ &\quad - 15n - 6] \end{aligned}$$

$$= \frac{(n+1)}{6} [6n^3 + 9n^2 + n - 1]$$

$$\therefore S_4 = \frac{n(n+1)(6n^3 + 9n^2 + n - 1)}{30} \quad (1)$$

Second Method to Find Σn^4

To find S_4 , we arrange its terms in the following way

$$\begin{aligned} S_4 &= 1^4 + 2^4 + 3^4 + \dots + n^4 \\ &\quad + 2^4 + 3^4 + \dots + n^4 \\ &\quad + 3^4 + \dots + n^4 \\ &\quad \dots + n^4 \end{aligned}$$

Hence the i th row in S_4 is $1^4 + (1+1)^4 + (1+2)^4 + \dots + n^4$.

Sum of the i th row

$$= (1^4 + 2^4 + 3^4 + \dots + n^4) - [1^4 + 2^4 + 3^4 + \dots + (i-1)^4]$$

$$= \frac{n^2(n+1)^2}{4} - \frac{(i-1)^2(i)^2}{4}$$

$$= \frac{1}{4} (n^4 + 2n^3 + n^2 - i^4 + 2i^3 - i^2)$$

$$S_4 = \frac{1}{4} (\Sigma n^4 + 2 \Sigma n^3 - \Sigma i^4 + 2 \Sigma i^3 - \Sigma i^2)$$

$$\begin{aligned} &= \frac{1}{4} \left[n^5 + 2n^4 + n^3 - S_4 + \frac{2n^2(n+1)^2}{4} \right. \\ &\quad \left. - \frac{n(n+1)(2n+1)}{6} \right] \end{aligned}$$

$$\text{or, } S_1 + \frac{1}{4} S_4 = \frac{1}{4} \left[n^5 + 2n^4 + n^3 + \frac{n^2 (n+1)^2}{2} - \frac{n (n+1) (2n+1)}{6} \right] = \frac{n(n+1)}{6} [6n^3 + 6n^2 + 3n^2 + 3n - 2n - 1]$$

$$\text{or, } \frac{5}{4} S_4 = \frac{1}{4} \left[n^4 (n+1) + n^3 (n+1) + \frac{n^2 (n+1)^2}{2} - \frac{n(n+1) (2n+1)}{6} \right] \quad \text{or, } 5S_4 = \frac{n(n+1)}{6} [6n^3 + 9n^2 + n - 1]$$

$$\text{or, } S_4 = \frac{n(n+1) (6n^3 + 9n^2 + n - 1)}{30} \quad (2)$$

$$\text{or, } 5S_4 = n (n+1) \left[n^3 + n^2 + \frac{n (n+1)}{2} - \frac{(2n+1)}{6} \right]$$

Expressions (1) and (2) are identical. Similar rearrangement of terms may be made to find the sum of the higher powers of the first 'n' natural numbers.

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The Metre Scale Bar Pendulum

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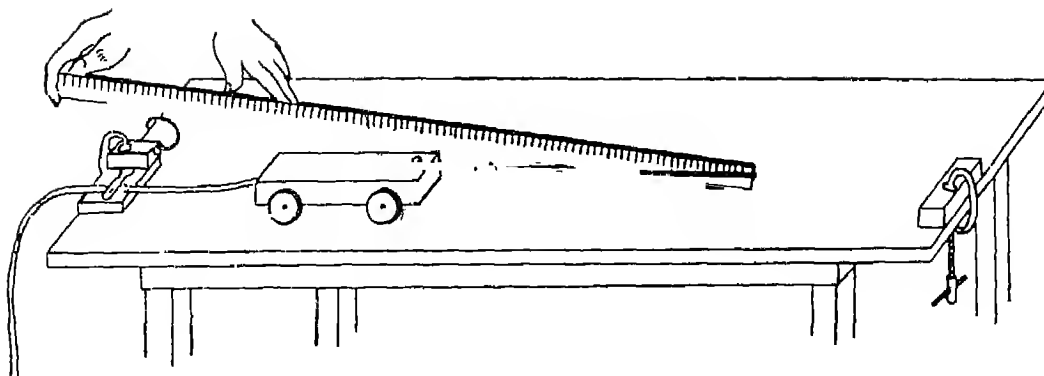
To demonstrate inertia of translatory motion there exist very simple and direct demonstrations which illustrate that acceleration produced in a body is proportional to force and thus F/a can be taken as a measure of inertia of a body. The use of a bar-pendulum, as described below, gives an equally simple, clear and direct demonstration of rotational inertia and enables it to be measured

To demonstrate inertia of translatory motion there exist very simple and direct demonstrations which illustrate that acceleration produced in a body is proportional to force and thus F/a can be taken as a measure of inertia of a body. The use of a bar-pendulum, as described below, gives an equally simple, clear and direct demonstration of rotational inertia and enables it to be measured. Construction of a low-cost bar pendulum made out of an ordinary metre scale is described, which can be used in place of the standard bar pendulum, for any experiment

Perhaps the best experiment for this purpose is the accelerated motion of a trolley on a horizontal plane. Acceleration is produced by pull of a thread which passes over a pulley and has a pan suspended at the other end. Any desired force can be applied to pull it by placing weights in the pan. Acceleration produced is measured by one of the several methods :

- (i) A vibrator attached at its rear may form a wavy curve on a paper placed below. It gives distances moved in successive intervals equal to time period of the vibrator.
- (ii) Trolley may have a store of ink, which comes out of a narrow orifice at the rear of the trolley. The ink drops fall at equal intervals of time on a paper placed below. Thus, again we measure distances moved in successive intervals equal to time intervals between successive drops.
- (iii) The trolley pulls a paper tape of negligible weight attached at its rear. The paper tape passes through a ticker-timer which marks dots on it after equal time intervals (of duration of the order of 0.02 second) equal to the period of vibration of a vibrator in it whose oscillations are electrically maintained. Thus, again we are able to find out distances moved in successive equal time intervals.

From the data of force applied and acceleration produced one finds out that acceleration is proportional to force. In fact, F/a increases slightly with increasing force, because the pan and weights in it share the acceleration of the trolley. Thus F/a is proportional to total mass of (trolley + pan + weights). If the force is applied by identical rubber bands stretched to a length of about 50 cm to 80 cm, the force being varied by varying the number of rubber bands, the mass that moves is constant (Fig. 1)



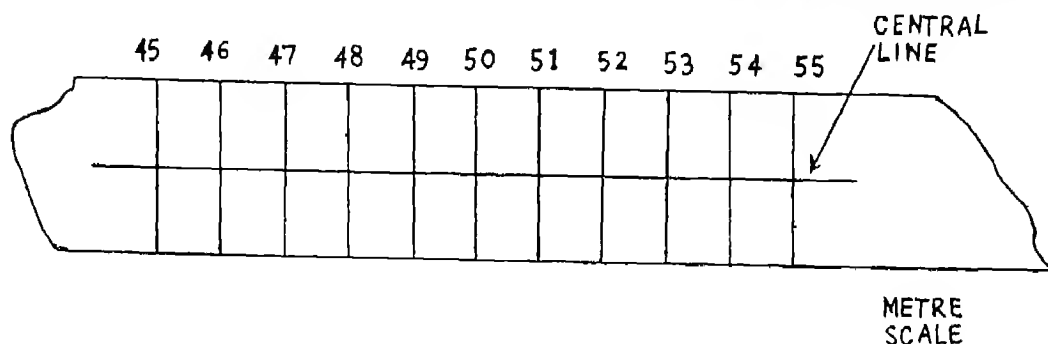
But, with this arrangement, the results are not quite accurate because while the trolley moves, it is difficult to maintain constant elongation of the rubber band.

Construction of Metre Scale Bar-Pendulum

In an ISI marked wooden metre scale, a fine line is marked parallel to its length from 45 cm mark to 55 cm mark in the centre of its width with a sharpened pencil. The tip of the pencil is chisel-shaped so that a line of thickness about 0.2 mm or 0.3 mm can be drawn by it. Then each cm-mark on one edge is joined with the opposite cm-mark on the edge (Fig 2). Intersections of these 11 lines along width with the central line along length give eleven points at 1 cm spacing where fine holes (diameter not exceeding $1/16$ inch or 1.6 mm) are drilled perpendicular to the plane of the scale.

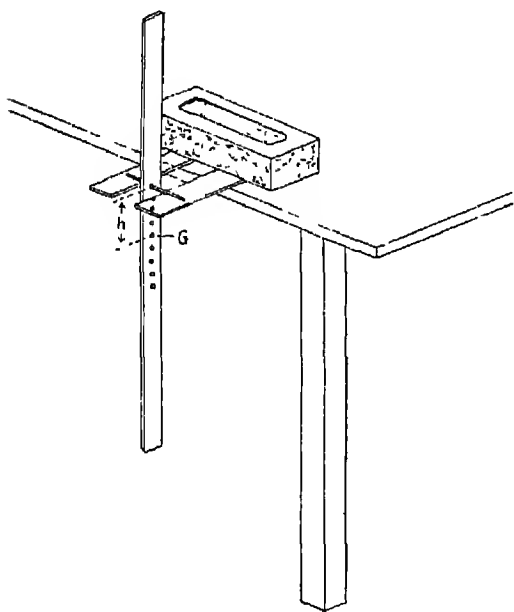
Before making a hole, a punch mark is made accurately at the intersection of the lines with the help of the pointed end of the compass (in one's geometary box), or by a specially sharpened nail not thicker than the drill. The punch marks are examined visually before making holes. If any of the punch marks is not at the intersection of the lines, it is filled with chalk powder mixed in fevicol or arldite, allowed to set for 24 hours and a new punch mark made next day, accurately at the intersection of the lines. For making holes perpendicular to plane of the scale, use a machine with a stand in which the direction of drill-bit is pre-set perpendicular to the base. If a hand-drill is used let a colleague see and judge if the direction of the drill is perpendicular to scale.

According to ISI specifications, the error in mutual distance between any two marks on the



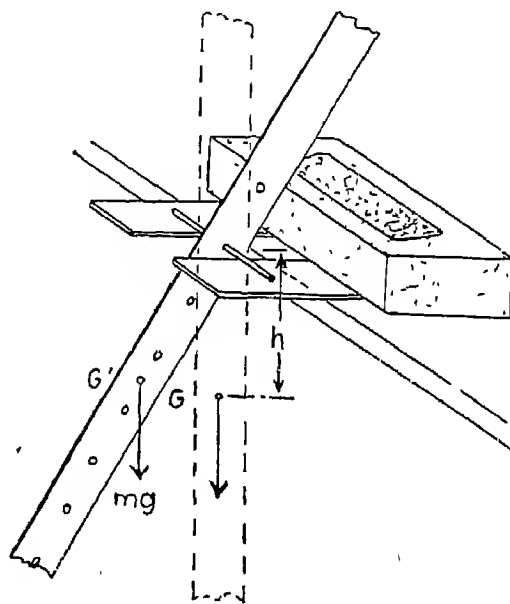
metre scale up to 10 cm apart does not exceed 0.25 mm. This is roughly true for these holes too, when procedure described above is followed*.

The drill with which the holes are made, can now serve as the axle. If top smooth part of an old broken drill of same size is available, it is a better axle for the experiment as well as eliminates the risk of breaking the new drill when it is used as the axle. By inserting the axle into any of the holes, the metre scale can be suspended vertically on two glass supports projecting out from the table (Fig. 3). The



* In an attempt made by the Junior Research Fellow at the DES & M, NCERT, mutual distances between pairs of holes were checked by inserting two drills in the concerned pair of holes and measuring the distance between the drills by a vernier callipers. The magnitude of error in the distance between any two holes was found not exceeding 0.3 mm. In many cases, the error was not observable by the vernier callipers and standard error was about 0.1 mm.

glass supports are about 5 cm × 20 cm rectangular pieces of 5 mm thick glass sheet. Their edges are ground to avoid risk of injury to the student working on the experiment. They are put on the table, about 15 mm to 20 mm apart from each other, projecting out from the table about 5 cm and held on the table by a heavy load, e.g., a brick. The metre scale can now oscillate freely in a plane perpendicular to the edge of the table (Fig. 4).



Procedure of the Experiment

First the C.G. of the metre scale is found by balancing it on a knife edge. It is usually not on the hole at 50 cm mark (Fig 2). Now time period of oscillations, T , of the scale is measured with the axle in a hole at distance h from the C.G. This measurement is repeated for a number of holes at various distances from C.G.

If C.G. is not on the central line, as happens when the scale is not quite straight, then the scale may not hang vertically on the hole at 49 cm mark, or 51 cm mark, or both.

Whenever the equilibrium position of the scale is roughly vertical (deviating from vertical less than, say, 5°) then distance of C.G. from the point of suspension, can be simply taken as the difference between scale readings at the C.G. and at the centre of that hole. Hence neglect the hole(s) for which equilibrium position deviates by more than 5° from vertical

Interpretation of Data

From the data of T and h so obtained it is observed that $1/T^2$ is proportional to h as the graph between them is a straight line passing through the origin, we know from the equations of simple harmonic motion that

angular acceleration $\theta = -\omega^2 \theta$

$$= \frac{-4\pi^2}{T^2} \theta \quad (1)$$

Thus $1/T^2$ can be taken as a measure of angular acceleration produced for a standard displacement, say $1/4\pi^2$ radian. Also the restoring couple due to gravitational force acting at the C.G. of the scale is proportional to h , considering the same standard displacement, i.e. $1/4\pi^2$ radian. Hence the conclusion of the experiment is that angular acceleration produced in the scale is proportional to restoring couple. Their ratio measures the rotational inertia, I . Restoring couple for an angular displacement θ , is equal to $mgh \theta$ (Fig. 5)

Equation of motion is

$$I\theta = -mgh\theta \quad \dots(2)$$

$$\text{or} \quad \theta = -\frac{mgh}{I} \theta$$

$$\therefore \quad T = 2\pi \sqrt{\frac{I}{mgh}}$$

$$\text{or} \quad T^2 = \frac{1}{I} \frac{mgh}{4\pi^2} \quad \dots(3)$$

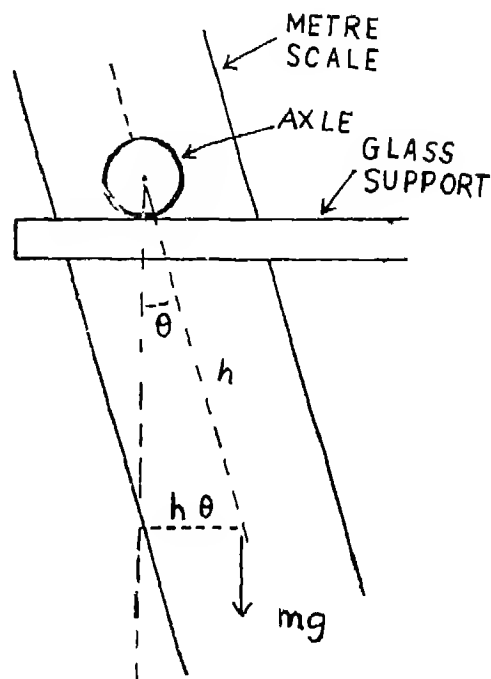
Thus a graph between $1/T^2$ versus h is plotted taking $1/T^2$ along Y-axis. It is a straight line passing through origin. Its slope :

$$\text{Slope} = \frac{\text{Increment in } 1/T^2}{\text{Increment in } h} \quad \dots(4)$$

is found out. Then angular inertia of the scale

$$I = \frac{mg}{4\pi^2} \times \frac{1}{\text{slope}} \quad (5)$$

can be calculated

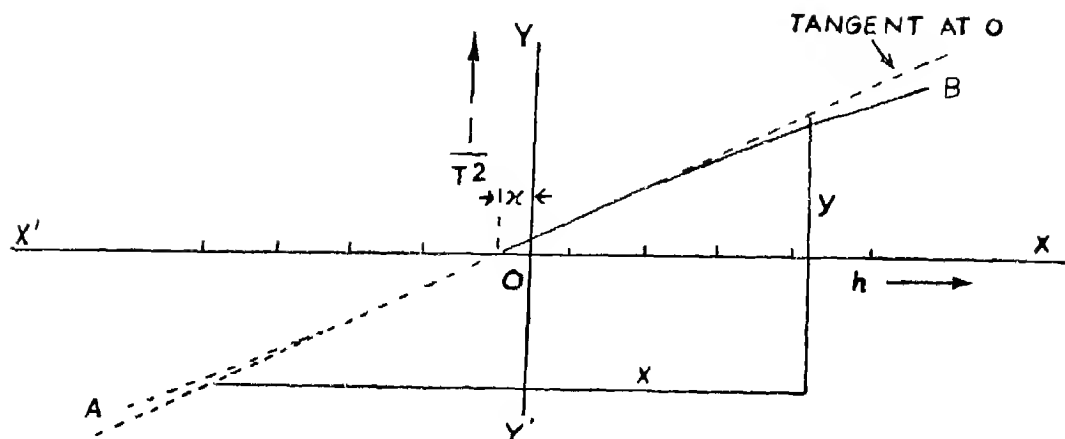


Clarification

(1) Angular inertia (or moment of inertia) of a body depends on the axis about which it rotates. However, in case of a metre scale 100 cm long, the moment of inertia about any point within 5 cm of C.G. is not significantly different from that about C.G.

(2) It is usually not possible to find the C.G. of the scale with an accuracy of 0.25 mm. Hence for points of suspension to the right of C.G. (positions 51 cm to 55 cm) plot the points in first quadrant and those on the left (positions 45 cm to 49 cm) in the third quadrant (Fig. 6). Then plot the graph on twice enlarged scale. This eliminates the error due to error in finding C.G., for the following reasons :

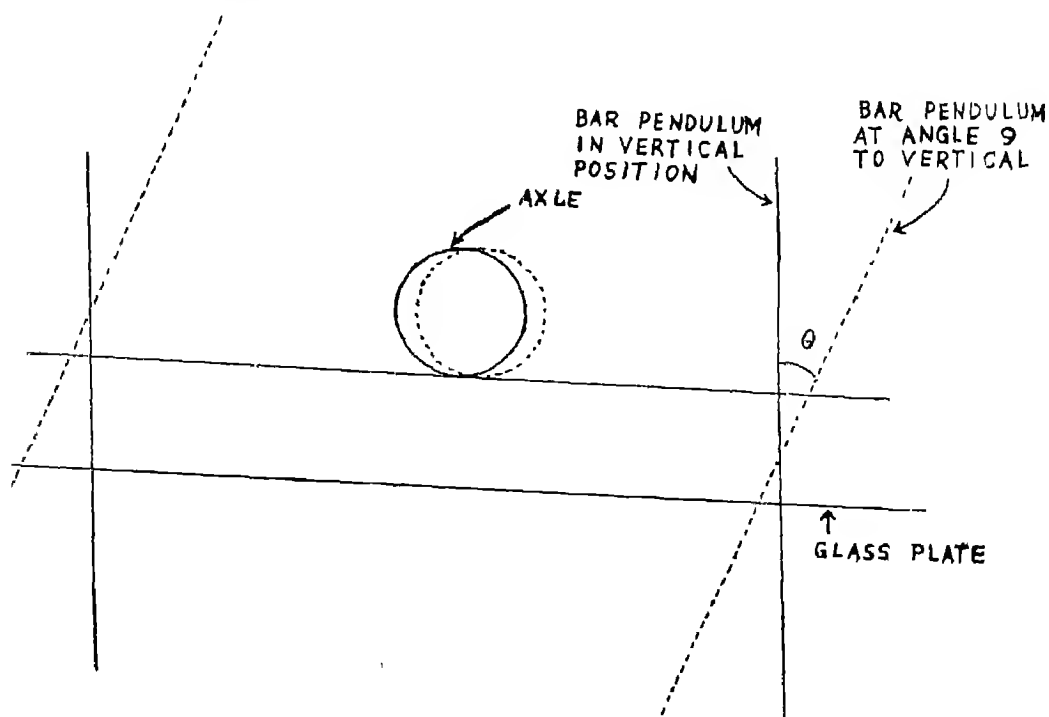
Let x be the error in finding the C.G., i.e. actual position of C.G. on the scale is at $c-x$,



if c is the position of C.G. as found by a student. Then each value of h found by the student for holes at 51 cm to 55 cm marks is too small by x and for holes at 45 cm to 49 cm marks is too large by x . Thus, in the graph plotted by the student, only a shift of origin to left by a distance x will make this correction. In other words, the straight line graph

made by the student will cut the axis representing h at a distance x to the left of the origin.

(3) In this experiment, the bar-pendulum is not suspended over a knife edge, which could provide an unchanging axis at the edge about which the bar rotates. Instead there is a cylindrical rod of finite diameter rigidly fixed to it (Fig. 7), which functions



as the axle. A detailed analysis shows that in this case the time period is

$$T = 2\sqrt{\frac{k^2 + (h-r)^2}{gh}} \quad \dots(6)$$

where h is the distance of the C.G. from the axis of the cylindrical rod,

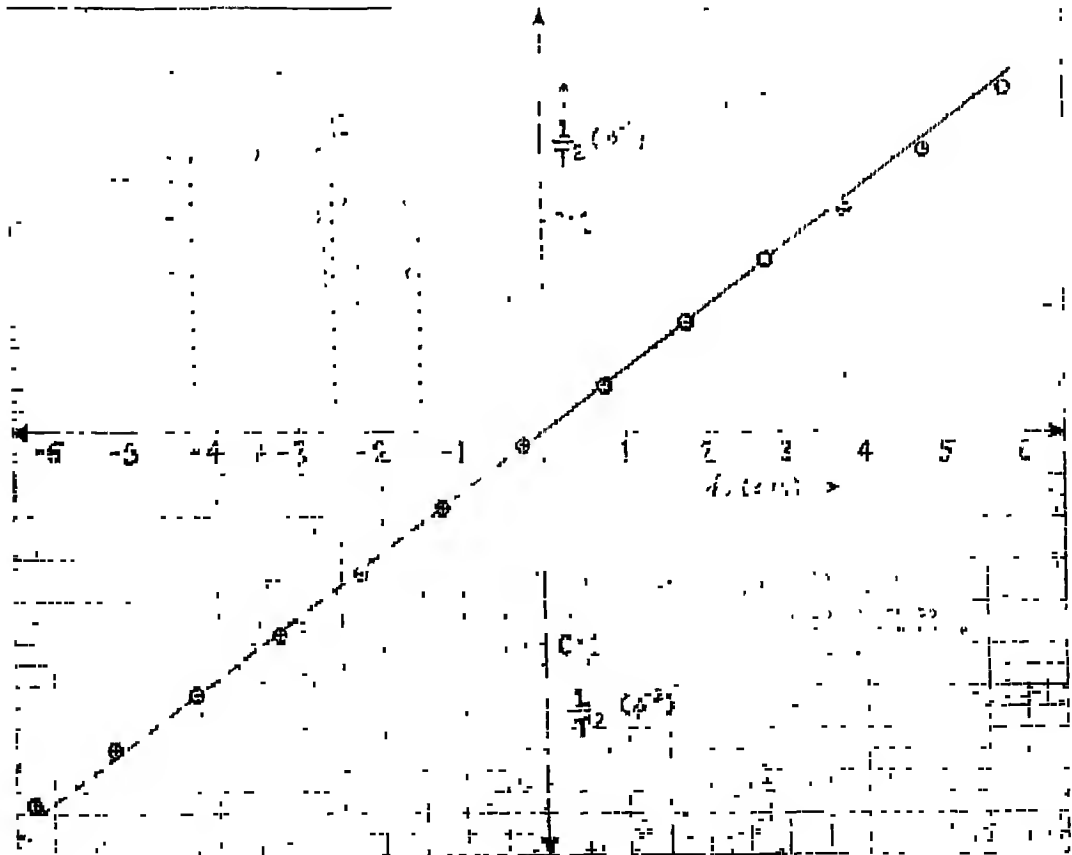
r is the radius of the cylindrical rod,

and k is the radius of gyration of the metre scale about its C.G.

This relation also accounts for increase in moment of inertia when axis of rotation does not pass through C.G. A little calculation will show that if the axle is a rod with a radius of 0.8 mm instead of a knife edge, the change in T is less than 0.1% which may be

neglected. Important caution, however, is that h is measured from the axis of cylindrical rod.

(4) Equation (6) given above shows that at $h=5$ cm time period of the metre scale is about 1.4% more than what the straight line graph between $1/T^2$ and h requires. This is due to slightly greater moment of inertia about the 45 cm or 55 cm mark than that about C.G. In Fig. 8, line AOB shows the nature of graph between $1/T^2$ and h . The straight line whose slope when substituted in the equation (5) above will give moment of inertia about C.G. is tangent to this graph at the origin. Figure 8 shows the graph obtained in a typical experiment.



(5) Due to large percentage error in measurement of h this experiment cannot be expected to give an accurate value of moment of inertia. The significance of this experiment lies in a simple and direct demonstration of the existence of rotational inertia in a body free to rotate about an axis.

Other Experiments by the Metre Scale Bar Pendulum

Like the standard bar pendulum, this bar pendulum made out of a metre scale can be used for following experiments too:

(1) Study of variation of its time period, while the position of the point of oscillation changes over its entire length. This experiment only requires a few more holes to be made in the metre scale from 5-cm mark to 95-cm mark at mutual distance of 5 cm or 10 cm.

(2) Study of variation of moment of inertia with position of axis of rotation and experi-

mental verification of parallel axis theorem. Moment of inertia, I , about any position of the axis of rotation may be found by finding the time period of oscillations about that axis and then using the relation (3) above, a graph between I and h^2 may be drawn which is found to be a straight line. Its intercept on the I -axis, gives the moment of inertia about C.G.

Acknowledgement

Thanks are due to all members of the Writing Team for Physics Laboratory Manual for Class XI in allowing the authors a free hand in designing new experiments for this curriculum. Thanks are also due to Sh. Om Prakash, Junior Research Fellow and Shri T.S. Verma, Laboratory Assistant for their assistance in constructing this equipment and doing this experiment many times over, without which this developmental work was not feasible.

How Good are you in Science ?

SMRITI SOOD

J.P.E., DESM
N. C. E. R. T.,
New Delhi

Tickmark the correct answer .

- 1 Amoebic dysentery is caused by
a) plasmodium b) tape worm
c) entamoeba d) amoeba
2. Which of the following diseases is not caused by virus ?
a) chickenpox b) cholera
c) measles d) poliomyelitis
- 3 Ring worm is caused by a
a) fungus b) bacterium
c) round worm d) hook worm
- 4 Which of the following animals is single celled ?
a) Daphnia b) hydra
c) Rotifers d) paramoecium
5. The most poisonous snake found in India is
a) cobra b) viper
c) krait d) python
6. Insects respire through minute holes on their body called
a) cilia b) spiracles
c) lungs d) nephridia
- 7 How many pairs of cranial nerves are present in human beings ?
a) 6 b) 10
c) 12 d) 16
8. The bird which covers the longest distance for migrating is
a) woodpecker b) arctic tern
c) wagtail d) siberian crane
9. The biggest flower in the world is
a) cucurbita b) wolffia
c) rafflesia d) lotus
10. Which of the following is a plant growth regulator ?
a) chromatin b) chlorophyll
c) urea d) cytokinin
- 11 For seed germination, which of the following is NOT essential ?
a) light b) air
c) water d) manure
12. Cauliflower is a part of plant of the nature of a
a) flower b) bud
c) inflorescence d) stem
13. The plant which feeds on insects is
a) dragon flower b) pitcher
c) mushroom d) algae
- 14 The green pigment present in plant is called
a) chromatophyll b) haemoglobin
c) chlorophyll d) chromosome
15. Which of the following is the most abundant element in the sun's atmosphere ?
a) Hydrogen b) Oxygen
c) Helium d) Krypton
16. The fourth state of matter is
a) smoke b) plasma
c) mist d) colloid
17. The standard voltage of a.c. supplied for domestic use is
a) 240V b) 210V
c) 220V d) 300V

18. The radius of a sphere is measured by
a) spherometer b) vernier calliper
c) spirometer d) screw gauge
19. Astigmatism can be corrected by wearing
a) concave lenses b) convex lenses
c) cylindrical lenses
d) photochromatic lenses
20. The credit of the discovery of telegraphy goes to
a) Sir Henry Bacquerrel
b) Alfred Nobel
c) Samuel Morse
d) Graham Bell
21. The filament of electric-bulb is made of
a) chromium b) tungsten
c) lead d) constantan
22. Which of the following colours has maximum wave length ?
a) Red b) Blue
c) Green d) Violet
23. Which of the following materials is used in putting a fractured limb in a cast ?
a) Limestone b) Chloroform
c) Gypsum d) Plaster of paris
24. Which of the following is an alloy of aluminium ?
a) Brass b) Steel
c) Duralium d) Bronze
25. The gas used in the cooling unit of a refrigerator is
a) neon b) freon
c) ozone d) argon
26. A photographic film is coated with
a) potassium iodide
b) silver chloride
c) silver bromide
d) silver nitrate
27. Stain of coffee, tobacco or tea leaves can be removed by
a) oxalic acid b) citric acid
c) hot saline water
d) sulphuric acid
28. Deuterium is an isotope of
a) nitrogen b) hydrogen
c) oxygen d) sulphur
29. Which of the following substances has highest malleability ?
a) Silver b) Gold
c) Copper d) Iron
30. Which of the following substances has maximum ductility ?
a) Gold b) Nickel
c) Zinc d) Copper

ANSWERS

- | | | | | | |
|------|-------|-------|-------|-------|-------|
| 1 c | 2. b | 3. a | 4 d | 5. a | 6. b |
| 7 c | 8 b | 9. c | 10. d | 11 a | 12 c |
| 13 b | 14 c | 15. a | 16. b | 17. c | 18 b |
| 19 c | 20 c | 21. b | 22. a | 23. d | 24. c |
| 25 b | 26. c | 27. a | 28. b | 29. a | 30. a |

Science News

Violent Peak of Sunspots Imminent

Sunspots, those dark blemishes on the sun's face that bloom into magnetic storms and shower havoc on earthly communications are approaching what may be called the most violent period in the past 250 years

Sunspots have been superstitiously blamed over the centuries for phenomena ranging from insanity to rabbit proliferation. Scientists still do not understand their full impact on earth. But it is clear that these cooler and darker regions on the sun's surface do have a big impact on the planet. They are outward signs of magnetic events on the sun and herald a period of massive magnetic storms that block communication satellites from orbit and cause surges of power in electric lines. During these storms, flares of energy some times erupt and arch out thousands of miles from the sun releasing in a few days energy equivalent to millions of hydrogen bombs.

Sunspots recur in 11-year cycles, going from zero in the low month of cycle to 100 to 200 a month at its peak. The peak is now approaching and it may be one of the most violent in the past 250 years.

The peak number of sunspots is expected in December 1989 with the intensity gradually increasing until then. But so far more sunspots have flared up than at the same stage of the greatest recorded periods of solar disruption in 1870 and 1857.

Sunspots were first observed by Chinese astronomers 2,200 years ago. For decades, people have tried to find connections between sunspot cycles and earthly phenomena. The real effects of geomagnetic storms include blackouts of radio and other communication, satellites damaged by electrical charges or pulled down from their orbits and surges of electrical current that sometimes shut down power lines.

Since 1729 twenty three sunspot cycles have been recorded. The shortest cycle had been seven years and the largest 17. The average is 11.1 years.

N-Plants 'Out of Fashion'

While India will be commissioning a new atomic plant in Naora later this year, nuclear stations are going out of fashion in several countries. The USA and most European countries have essentially stopped building nuclear power plants according to a report by the World Watch magazine.

In May a company that built a nuclear power station at Long Island at a cost of \$5,300 million sold it to New York State for \$1 without operating it. "Nuclear power has become expensive, its growth has been mismanaged and an increasing number of citizens are rejecting it", says Mr Christopher Flavin, author of the report and vice-president of the World Watch Institute.

The US nuclear construction industry has for the most part disappeared and the pipeline of new projects is nearly empty, sustained only by a handful of plants that are a decade behind schedule. Most US nuclear facilities completed in the 80s are grossly uneconomical, providing power that is five times as costly as that from plants completed a decade ago.

In Europe several countries have made formal commitments to shut down their nuclear programmes in the wake of Chernobyl. Australia has abandoned its only nuclear plant that was built but never operated. Greece has scrapped plans to build its first nuclear plant. Italian Government has decided to stop work on the country's only remaining nuclear project. Belgium has decided to indefinitely postpone nuclear expansion plans while the Netherlands which had no large reactors, cancelled its plans. Switzerland has cancelled plans to build its sixth nuclear facility. According to the report, Scandinavia's nuclear programmes have been moving in the reverse direction with Finland stopping further expansions. Sweden decided to phase out nuclear power by 2010, and Denmark and Norway reaffirmed their vows "never to develop nuclear power".

Nuclear opposition had flourished in West Germany further weakening the already remote possibility of the country's building additional nuclear plants.

France remains Europe's only pro-nuclear holdout but its programme is plagued by a growing number of plant breakdowns and a \$ 39,000 million debt.

In the Soviet Union, citizens' groups and local officials now openly oppose ambitious plans to double nuclear dependence in next decade, the World Watch study said. This opposition has led to the cancellation of six nuclear projects since Chernobyl. Nuclear power is also dimming in Britain which is closing down its first commercial plant at Berkeley and has slashed funds for fast reactor research.

Radioactive Dinosaur Bones Found

Ancient dinosaur bones recovered from hillside near Rahioli village in Gujarat's Kheda district are highly radioactive, according to Dr U. B. Mathur, the Geological Survey of India scientist.

Researchers have attributed the radioactivity to an unusually high content of uranium in the bones. Reporting the find in an issue of *Current Science*, Dr U. B. Mathur said that discovery could open up a new area for the search for commercial deposits of radioactive minerals in the region.

Chemical analysis of the bones, at least 65 million years old, at the GSI Regional Paleontological Laboratory in Jaipur have revealed that the uranium content in the bones ranges from 300 parts per million (PPM) to 700 PPM.

The presence of the uranium in the bones can be explained by the gradual replacement of phosphate ions in the fossils by uranium derived from ground water percolating in the area.

Though fossil hunters have dug out dinosaur bones at several sites in the country before, this is the first discovery of radio-active dinosaur bones.

However, dinosaur fossils from Wyoming in north western USA also display radioactivity that scientists say is due to the presence of uranium oxides.

Geologists here say that the uranium found in the Rahioli bones might be an indicator to several deposits of uranium in the vicinity. One possible source of uranium could be the granite like stones called pegmatites over which the fossil containing layers called lamella sediments are located.

So far the only other sedimentaries which are contemporaneous to lamellas and also known for uranium concentrations are the Mahadeo formation of the Khasi hills in eastern India, he added.

An alternative source for the uranium could be the acid rocks of the Deccan trap formation. The highly oxidizing conditions would have oxidized the uranium which was then substituted in the lattice of the dinosaur fossil bones.

New Technique to Prevent Heart Attacks

Scientists have developed a technique that

may be able to pinpoint blocked coronary arteries, identifying patients at risk for heart attacks before any symptoms appear.

The method uses a nuclear imaging technique called Positron Emission Tomography. PET. Dr Thomas Budinger, head of the research medicine division at the Lawrence Berkley Laboratory, said that they had developed a technique for evaluating the flow of blood to the heart muscle—a measurement that reflects the health of the coronary arteries.

Currently only a coronary angiogram can show arterial blockage. This is a complicated, expensive and risky procedure. In contrast, the PET scans could be performed in the doctor's chamber as part of an annual check up and could point out potential trouble long before any outward symptoms appeared.

The patient is injected with a positron emitting radioactive tracer rubidium-82 and a three dimensional image of the tracer on crystals enables doctors to follow the course of organic processes in progress.

Dr Budinger's team began human tests two years ago on patients with arteriosclerosis and heart disease

Two PET scans are taken—one directly after exercise, and the second after a short rest. In the diseased patients the difference between the two images is remarkable—Dr. Budinger said.

Such ability to measure blood flow is specially important with the introduction of drugs which are injected into coronary arteries to dissolve clots during a heart attack

Cholera Vaccines Waste of Resources

The World Health Organisation and the

Director-General of Health Services, Government of India have clearly stated that the 'Cholera vaccine currently available does not contain the spread of the disease or prevent the outbreak or save the lives of the affected persons' They have advised the Government and concerned public health authorities to discontinue the use of anti-cholera vaccines as it is a sheer waste of resources.

To quote the relevant WHO guidelines (issued in 1986) on cholera control, read : (1) The vaccines available at present are not helpful in the control of cholera; (2) Their efficacy, even when they have the required potency, is only around 50-60% lasting for three to six months but most of the vaccines do not have the required potency (producers do not test the potency of the vaccines)' (3) Vaccination does not alter the severity of the disease and does not reduce the rate of asymptomatic infections. Thus it cannot prevent the introduction of cholera into a country or its spread within an area; (4) Vaccination gives a false sense of security to those vaccinated and feelings of accomplishment and complacency to the health authorities, who consequently neglect the more effective precautions, (5) Vaccination campaigns are, therefore, wasteful of scarce resources.

Having realized that the available cholera vaccines were of no use the WHO in 1973 abolished the requirement of a certificate of vaccination against cholera in International Health Regulations

Cancer Research by 14-year Old

Ray Bateman, a 14 year high school freshman and computer whiz, spent more than 1,300 hours researching the project on colon cancer. When he presents his research on colon cancer at a conference next month, he might raise

eyebrows not because of his findings but because of age

Bateman's co-researcher and next-door neighbour cancer specialist Dr Glenn Tisman, said that few will doubt his competence by the end of his presentation. "Working with him was like working with a post-doctoral fellow. His

abilities are remarkable and he is full of knowledge about chemistry even though he hasn't ever taken a chemistry course in school. But he's still a kid, basically. My lab technician used to complain that Ray would leave his candy wrappers lying around".

SCHOOL SCIENCE

Vol. XXVI No. 4 DECEMBER 1988



*A geometrical construction
by
Leonardo da Vinci*

SCHOOL SCIENCE is a quarterly journal published by the National Council of Educational Research and Training. Intended to serve teachers and students in schools with the recent developments in science and science methodology, the journal aims to serve as a forum for the exchange of experience in science education and science projects. Articles covering these aims and objectives are invited. Manuscripts, including legends for illustrations, charts, graphs, etc. should be neatly typed double-spaced on uniformly sized paper, and sent to the Editor, **SCHOOL SCIENCE**, Department of Education in Science and Mathematics, NCERT, Sri Aurobindo Marg, New Delhi 110016. Each article may not normally exceed ten typed pages.

The articles sent for publication should be exclusive to this journal.

Illustrations may be limited to the minimum considered necessary, and should be made with pen and indelible Indian ink. Photographs should be on glossy paper, at least of postcard size, and should be sent properly packed so as to avoid damage in transit.

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Annual : Rs. 16.00

Single Copy : Rs. 4.00

SCHOOL SCIENCE

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TO OUR CONTRIBUTORS

SCHOOL SCIENCE invites articles from teachers, acquainting students with the recent developments in science and science methodology. The articles should be addressed to Executive Editor, Department of Education in Science and Mathematics, NCERT, Sri Aurobindo Marg, New Delhi-110016.

Philosophy of Education and Science Curriculum

MARLOW EDIGER

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Idealists believe in an idea-centred curriculum. One cannot know the real world as it truly exists. But, ideas pertaining to the natural and social world can be known. Ideas are stable and not subject to continuous change. Universal application of subject matter and standards of morality is vital.

Ralph Tyler asks four pertinent questions pertaining to developing the curriculum. These include

1. What educational purposes should the school seek to attain ?
2. What educational experiences can be provided ?
3. How can these educational experiences be effectively organized ?
4. How can we determine whether these purposes are being attained ?

No doubt, an improved curriculum would be an end-result if Ralph Tyler's questions were answered in the teaching/learning arena. Each learner may then perceive interest, purpose, and meaning in ongoing units of study.

Benjamin Bloom emphasizes that teachers establish goals involving higher levels of cognition. In ascending order of complexity, these cognitive levels include

1. Knowledge or recall level
2. Comprehension
3. Application
4. Analysis
5. Synthesis
6. Evaluation

Certainly, teachers need to guide pupils to go beyond the knowledge or recall level of teaching. Learners also need to comprehend or understand what has been recalled. Also, pupils need to make use of or apply what has been comprehended, as well as analyze, synthesize, and evaluate what has been acquired.

The balance of this paper will look at another dimension of teaching and learning. Thus, the philosophy of education also needs consideration in developing the curriculum.

An Idea-centred Curriculum

There are selected educators who emphasize implementing idea-centred science units. Ideas then become more relevant as compared to objects. One can only achieve ideas pertaining to the natural and social world, according to idealism as a philosophy of education.

Ideas to be acquired by learners need to have universal application. The ideas hold true in time and space and are not subject to continual change. Abstract subject matter rather than the concrete is to be prized.

Teachers and supervisors stressing an idea-centred science curriculum might well tend to emphasize the following :

1. Reading and discussing subject matter in ongoing units of study

2. Writing outlines, summaries, essays, reports, and notes covering content in science.

3. Listening to cassettes and records directly related to the ongoing science unit.

4. Working exercises in workbooks and duplicated worksheets in science

5. Developing moral standards applicable to preserving the natural environment.

6. Moving away from the finite to the Infinite Being

Idealists believe in an idea-centred curriculum. "One cannot know the real world as it truly exists. But, ideas pertaining to the natural and social world can be known. Ideas are stable and not subject to continuous change. Universal application of subject matter and standards of morality is vital

An Experience-centred Curriculum

Selected science teachers and supervisors believe in emphasizing an experience curriculum. It is significant then for learners to experience societal concerns in the school and class settings. Each individual experiences the curriculum of life in society. Thus, school and society should not be separated from each other, but become integrated entities.

Each person experiences problems in life. Each problem needs solution. Solutions to problems are tested in action. Results of solutions are modified and revised, if necessary.

Problems arise in society due to changing scenes and situations. Change is a key concept when society is experienced by learner. Problems in society become subject matter in the science curriculum.

Selected problems which pupils might identify with teacher guidance might include the following :

1. How can air, noise, water, and land pollution be minimized ?

2. What should be done with hazardous chemical wastes ?

3. How does the utilization of laser beams help human beings in society ?

A solution for each problem is sought using a variety of experiences, including reading, audio-visual aids, excursions, science experiments, and demonstrations

Answers to problem areas might then be developed. These solutions are held to be tentative, and never as absolutes. Solutions are modified, if consequences so indicate. Knowledge is not stable, but subject to continuous change

An Individualized Curriculum

There are selected teachers and supervisors who advocate that pupils make choices and decisions in terms of what to learn (the objectives) as well as the means of learning (activities and experiences). Many educators agree that choices and decisions be made by learners within a flexible framework with teacher guidance.

Examples of learners with teacher guidance choosing objectives and learning activities might involve the following :

1. Use of learning centres. The teacher may have developed each centre and task; however, each pupil determines which sequential experiences to pursue. Teacher-pupil planning might also be used to prepare each centre and task. The involved pupil must truly choose ordered experiences, and, thus, might even omit selected tasks at different centres.

2. Use of contract systems. Pupil-teacher planning may be utilized to determine the contents in the contract for the former to complete.

Existentialism, as a philosophy of education, believes in rather complete freedom for an individual to make choices and moral decisions. It is an awesome responsibility to make decisions. One must accept complete responsibility for choices made. The consequences of an act are a responsibility of the chooser. Morality is a key goal in decision making. Anarchy or selfishness on the part of the personal self is not at all a goal of an

existentialist. Soren Kierkegaard (1813-1855), Danish philosopher, believed that fear and trembling are a part of individual moral decisions made in relationship to others. Whether existentialism, in its extreme form, would work in the school curriculum has not been resolved. However, each person faces dilemma situations that do not have right or wrong solutions. These include

1. Saving the natural environment versus economic growth of a region, state, or nation
 - 2 Utilizing wind, tidal, and water power, among other innovations versus nuclear forms of energy.
 - 3 Favouring personal rights to abortion versus legislated standards of morality involved anti-abortion philosophies.
 4. Advocating spending money on domestic projects versus increased defence spending
- An attempt has been made to show relation-

ships between the utilization of learning centres and a contract system, with existentialism as a philosophy of education. Existentialism advocates the personal self in an atmosphere of complete freedom choosing and making decisions. A learning centres approach and a contract system might then, in degrees, reflect tenets of existentialism. However, the use of learning centres and contracts in teaching/learning situations provides more structure in the curriculum as compared to existentialist thinking in education and in life

In Conclusion

There are diverse philosophies of education in the teaching of science. Each philosophy needs studying and analyzing. Ultimately, teachers and supervisors need to select that which provides for interest, meaning, and purpose on the part of each learner

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Must a Science Lesson have Teaching Aids ?

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The present study was designed to seek empirical evidence regarding the indiscriminate prescription of 'teaching-aids' in the classrooms without caring for 'the nature of topics and levels of thinking' needed for understanding of science content by the children. Specifically, the following hypothesis was tested in this investigation.

There is no difference in the attainment of concepts at knowledge level related to the topics of silkworm, air pressure and laws of floatation when the scientific information is presented through the modes of filmstrip, lecture-demonstration-cum-filmstrip and lecture-demonstration for the VIII grade subjects.

Although we have been designated as the largest democracy in the world, we are highly authoritarian in our outlook in almost all walks of life. Education is no exception to this style of functioning. While researches in education should form a sound base for educational decisions, we seldom care for them. Opinions of people in authority are important in our culture and they are taken for granted as the golden rules for the educational processes as well.

The present study was designed to seek empirical evidence regarding the indiscriminate prescription of 'teaching-aids' in the classrooms without caring for 'the nature of topics and levels of thinking' needed for understanding of science content by the children. Specifically, the following hypothesis was tested in this investigation.

There is no difference in the attainment of concepts at knowledge level related to the topics of silkworm, air pressure and laws of floatation when the scientific information is presented through the modes of Filmstrip, Lecture-demonstration-cum-filmstrip and Lecture-demonstration for the VIII grade subjects.

Sample

A Hindi medium VIII class was selected as the experimental unit for this study. This class consisted of 34 boys. On the day of the starting of the experiment 30 boys were present. They were randomly assigned to three different groups. Hereafter, the groups would be known as GA, GB and GC respectively.

Selection of the Topics

Selection of the topics was done on the availability of the filmstrips in the college AV unit. Three topics met this criterion. They were Silkworm, Air pressure and Laws of floatation. Hereafter, these topics would be known as SW, AP and LP respectively.

Test Construction

On the content of each topic, i.e., SW, AP and LP, a 20 item 4-option multiple-choice test at knowledge level was prepared by the author, keeping in view the Bloom *et al* rationale for the first category of the taxonomy of educational objectives. Cognitive domain.

Treatment

To meet the requirements of the research hypothesis, the following design of the experiment was used in this study.

Experimental Design of the Study

Methods	Filmstrip FSM	Lecture- dem-film- strip LDFM	Lect-demonst- ration LDM
Topics			
Silkmoth	GA	GB	GC
SW	FSM	LDFM	LDM
	SW	SW	SW
Air pressure	GC	GA	GB
AP	FSM	LDFM	LDM
	AP	AP	AP
Laws of Floatation	GB	GC	GA
LF	FSM	LDFM	LDM
	LF	LF	LF

Lesson Plans

For the requirement of homogeneity of the content-coverage, each filmstrip was pre-viewed by the experimenter and outline lesson plans on them were written. The experiment was completed in 4 weeks time.

Test Administration

At the end of each treatment, next day, the test was administered to Ss in their regular classes. Each test was scored according to its key.

Results

In order to partition the variance of the variables, ANCOVA was run. The results are detailed in the accompanying table.

There was a significant difference among the three topics, i.e. Silkwoim, air pressure and laws of floatation ($F(2,42)=9.83$, $p<.01$), while there were no significant differences

among (a) the filmstrip, Lecture-demonstration-cum-filmstrip and Lecture-demonstration methods ($F(2,42)=0.67$, $p>.05$); (b) the three groups ($F(2,42)=0.77$, $p>.05$) and (c) the individuals ($F(23,42)=0.49$, $p>.05$)

Discussion

A look at the three topics used in this experiment would reveal 'Silkwoim' as the easiest topic in content-difficulty, while the other two topics, i.e., 'air pressure and laws of floatation' would be far more difficult for many VIII grade Ss. This has been clearly reflected in answering questions hinged at knowledge level. Hence, the three topics show significant F ratio ($F=9.83$, $df 2,42$; $p<.01$). On the other hand methods used were utilized to present content-knowledge of the topics, and they did not produce any effect at testing of 'declarative knowledge' ($F=0.67$, $df 2,42$; $p>.05$). Individuals involved in this experiment as well formed a homogeneous group, as is evidenced by the insignificant F ratio ($F=0.49$, $df 23,42$; $p>.05$). The elementary paradigm of 'Teaching-Aids' effectiveness is perceived by the advocates on the S-R model of learning. Transmission and testing of scientific knowledge might prove useful as an educational strategy at the lowest level of understanding but this might result in burdensome drudgery for pupils whose 'encodement of information is schematic and symbolic rather simply iconic preference'. Indiscriminate prescription of 'T-Aids' presupposes single track encodement procedure, and ignores alternative media encodement formats. In fact, individual variations are a rule rather than exceptions to this phenomenon. Thus, a prerequisite for the media-content-negotiation resides in the cognitive structure of the learner. How an individual stores information and keeps it handy for retrieval depends on his

ANCOVA for the Experimental Scores

Source of variance	SSQ	df	\bar{X} SQ	F	F 95%	F 99%	Sig
Methods	33.60	2	18.60	0.669	3.22	5.15	NS
Topics	493.50	2	246.75	9.83	3.22	5.15	.01
Groups	38.60	2	19.30	0.77	3.22	5.15	NS
Individuals	283.73	23	12.33	0.49	1.78	2.26	NS
Error	1053.97	42	25.09				
Total	1903.40	71					

'media of thought' not just on how information is made available to him. Although retrieval of information from the memory store is an important aspect of learning but the kind of transformation to be evoked depends on whether the individual limits himself to figurative or operative schemes. The former schemes remain unaltered when teaching and testing are pitched at information level alone. At times, media input probably does not help the individuals, except in the registering and retrieving of concepts at knowledge level, as has been reflected in this investigation. Cognitive development is contingent on the process

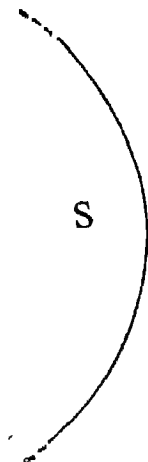
of 'interiorization'. For Piaget, "schemes are the product of interiorization and determine the format of information processing and knowledge storage". If 'T-Aids' are limited to presenting and testing of concepts at information level, not much is expected of the individuals, rather these should facilitate the learners to transform their figurative schemes for steering the organization of new information at the higher levels. Hence, it is suggested that 'T-Aids' should be exploited to activate mental representation needed for problem solving in sciences.

Problems on Weights and Weightlessness

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At the poles, a body has no orbital motion around the earth. At the equator, the body is revolving around the centre of the earth with the same speed as that of a point on the equator. This would cause a centrifugal force on the body which would have to be subtracted from the earth's gravitational pull to get the effective weight of the body.



1 It is well known that a person or a body orbiting a planet in a satellite loses weight. The person or body can float freely inside or outside the satellite (attached to it by a string).

The earth is also a natural satellite of the sun, and we are riding the earth in its orbits around the sun. Why don't we feel weightless?

2. Would there be a difference in the weight of a body at the poles and at the equator? If so, where would the body weigh less and by what fraction? (Assume a perfectly spherical earth with the same acceleration due to gravity at all points on its surface)

Solution to the Problems on Weights and Weightlessness

1 In the case of the man-earth system (both orbiting the sun), one component of the system, that is the earth, is so massive that it has enough gravitational attraction of its own. We feel weight due to this gravitational attraction of the earth.

Fig 1 shows the earth and one person (for simplicity) orbiting the sun. The main forces acting on the person would be (1) the gravitational force F_1 due to the sun, (2) the centrifugal force F_2 due to his motion around the sun, and (3) the gravitational force F_3 due to the earth. The first two forces cancel out as they are equal and opposite. We feel our weight due to F_3 which keeps us bound to the earth

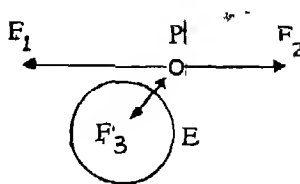


Fig. 1

Compare this with a person in a satellite orbiting the earth. The same diagram, Fig. 1, can represent this situation if we replace the earth by a satellite and the sun by the earth. Now the forces on the person would be (1) the gravitational pull F_1 due to the earth, (2) the centrifugal force F_2 due to his orbital motion around the earth, and (3) the gravitational force F_3 due to the satellite. F_1 and F_2 are again equal and opposite and cancel each other, leaving F_3 , the force exerted by the satellite on the person.

Now the mass of the satellite is very small (only a few thousand kg) as compared to that of the earth which is 6×10^{24} kg. The force F_3 due to the satellite on a person is therefore quite unnoticeable. The person in the satellite therefore feels weightless. Both the components of the system (the satellite and the person) have small masses and their gravitational effects are negligible.

2. At the poles, a body has no orbital motion around the earth. At the equator, the body is revolving around the centre of the earth with the same speed as that of a point on the equator. This would cause a centrifugal force on the body which would have to be subtracted from the earth's gravitational pull to get the effective weight of the body.

Notice that in this case, the centrifugal force on the body does not cancel the earth's gravitational force, as in the previous problem, because the body is not in a natural orbit around the earth. It is 'glued' to the earth's surface.

A point at the equator traverses a distance $2\pi R$ (where $R=6370$ km, the radius of the earth) in one day. Its linear velocity in the circular path therefore comes out to be

$$v = 40000 \text{ km/day} = 1667 \text{ km/h} = 0.463 \text{ km/s.}$$

It will therefore experience a centrifugal acceleration equal to

$$\frac{v^2}{R} = \frac{(463 \text{ m/s})^2}{6370000 \text{ m}} = 0.034 \text{ m/s}^2$$

The gravitational acceleration due to the earth's pull is known to be 9.81 m/s^2 . If this is considered to be its value at the poles, the effective value of acceleration due to gravity at equator would be

$$9.81 \text{ m/s}^2 - 0.034 \text{ m/s}^2 = 9.776 \text{ m/s}^2$$

Thus the effective acceleration due to gravity at the equator would be reduced by a fraction $0.034/9.81 = 0.0035$. The percentage reduction is 0.35% (about one-third per hundred). The reduction in weight of a body at the equator as compared to that at the poles would also be the same fraction (or percentage).

This effect is the largest on Jupiter among the planets of the solar system. This is because Jupiter completes one revolution around itself in 9 h 50 min which is the shortest period of revolution among the solar planets. Naturally, the centrifugal acceleration on a body at Jupiter's equator is the highest among planets.

The actual figures are given below.

$$\text{Mass of Jupiter} = 1.89 \times 10^{27} \text{ kg;}$$

$$\text{Average radius, } R = 70000 \text{ km} = 7 \times 10^7 \text{ m;}$$

$$\text{Therefore surface gravity, } g \text{ (Jupiter)} = 25.9 \text{ m/s}^2.$$

$$\text{Time of revolution, } T = 9 \text{ h } 50 \text{ min} = 35400 \text{ s,}$$

Therefore velocity of a point at equator, would be

$$v = \frac{2\pi R}{T} = 1.24 \times 10^4 \text{ m/s}$$

The centrifugal acceleration at the equator would thus be

$$g_c = \frac{v^2}{R} = 2.2 \text{ m/s}^2$$

The ratio of centrifugal acceleration to gravitational acceleration is thus $2.2/25.9 = 0.085$ or 8.5%. Thus a body on Jupiter's surface would weigh 8.5% less at the equator than at its poles.

Learning Through Riddles

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1 The Throne Carpet

King Vikramsingh was a great lover of art. He encouraged artists, not only those who lived in his kingdom but also those who came from abroad. Once it so happened that a great Kashmiri artist, named Rafi, appeared in his court and showed the king a variety of beautiful carpets he had woven. The king was greatly pleased and ordered Rafi to make a beautiful carpet to cover his throne. Rafi gladly agreed to do so and carefully studied the throne. The first thing which he noted was that the length of each step of the throne was equal but their widths and heights were different, as shown in Fig. 1

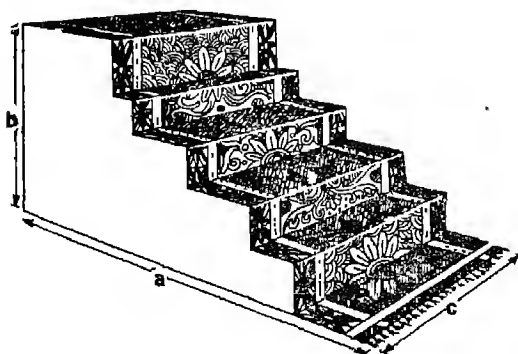


Fig. 1

Rafi, naturally, wanted the various measurements of the throne to know the size of the carpet to be made. Now, according to the royal tradition of the kingdom no one except the king could put his foot on the throne. Also, Rafi could not ask the king himself to measure the length, width and height of each of the steps. He also knew that failure in designing a properly fitting carpet would mean death. A worried Rafi took the king's permission to leave the court; went to the room where he was staying. For the whole night he pondered over the problem and thought of a solution when the cock crowed. He then happily retired to his bed. The following day he came to court and simply measured the lengths a , b and c (see Fig. 2). He found a to be 18 ft, b to be 15 ft and c to be 6 ft. He then designed a carpet $18+15=33$ ft long and kept the width of the carpet 6 ft. When he presented the carpet, thus designed, to the king, all the courtiers including the king himself were astonished to see how exactly the beautiful carpet fitted the throne.

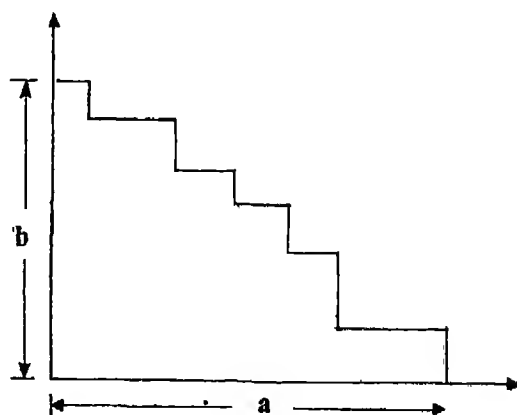


Fig. 2

How did it happen? Which principle helped Rafi in concluding that the length of the needed carpet is simply given by $a+b$? Let us see. For this purpose look at Fig. 3, where $1(A S)=b$ and $1(A G)=a$.

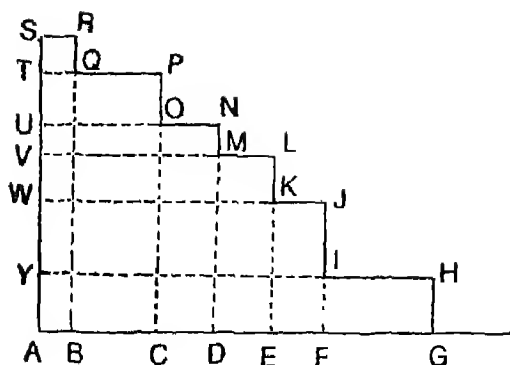


Fig. 3

We know that opposite sides of any rectangle are congruent. Hence from Fig. 3 we can say that

$$SR \cong AB$$

$$QP \cong BC$$

$$ON \cong CD$$

$$ML \cong DE$$

$$KJ \cong EF$$

$$IH \cong FG$$

Hence the sum of the lengths of line segments on the left side will be equal to the sum of lengths of the line segments on the right side.

$$\begin{aligned} \text{Hence } & 1(SR) + 1(QP) + 1(ON) + 1(ML) \\ & + 1(KJ) + 1(IH) \\ & = 1(AB) + 1(BC) \\ & + 1(CD) + 1(DE) + 1(EF) + 1(FG) \\ & = 1(AG) = a \dots \dots 1 \end{aligned}$$

Similarly,

$$\begin{aligned} 1(RQ) &= 1(ST) \\ 1(PO) &= 1(TU) \\ 1(NM) &= 1(UV) \\ 1(LK) &= 1(VW) \\ 1(JI) &= 1(WY) \\ 1(HG) &= 1(YA) \end{aligned}$$

Hence, adding, we get

$$\begin{aligned} & 1(RQ) + 1(PO) + 1(NM) + 1(LK) + 1(JI) \\ & + 1(HG) = 1(ST) + 1(TU) + 1(UV) \\ & + 1(VW) + 1(WY) + 1(YA) \\ & = 1(SA) = b \dots 2 \end{aligned}$$

Adding 1 and 2, we get

$$\begin{aligned} a + b &= 1(SR) + 1(RQ) + 1(QP) + 1(PO) \\ & + 1(ON) + 1(NM) + 1(ML) \\ & + 1(LK) + 1(KJ) + 1(JI) + 1(IH) \\ & + 1(HG) \\ & = \text{Length of the throne carpet} \end{aligned}$$

This was the calculation which helped Rafi in finding the length of the needed carpet.

Now let us look at this problem from a slightly different angle and see if we stumble across something paradoxical. Let us look at Fig. 4.

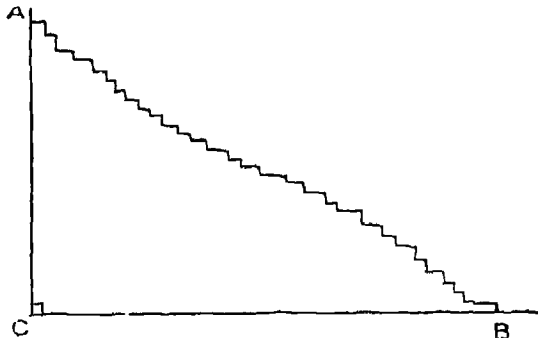


Fig. 4

If we keep on constantly reducing the widths and heights of each step then Fig. 3 gets changed to Fig. 4. AB is thus reduced to a zigzag line. Still the length of this zigzag line is equal to $(a+b)$. Also, we know that as we keep on reducing the size of steps the zigzag line AB resembles more and more a straight line segment AB. In other words, when we reduce the size of each step infinitely, the zigzag line AB becomes a straight line segment. Then our rule tells us that still the

length of straight line segment AB should be $a+b$. But this only means that in $\triangle ABC$, the sum of the lengths of its two sides is equal to the length of its third side and as we know this is impossible. Then where have we gone wrong to reach this paradox?

Well, the paradox hinges on the fact that we talk of infinity or endless but we always stop the sequence somewhere. We confuse here between infinite number of times and very large number of times. In the above example, one should remember that the length of the zigzag line AB will always be $(a+b)$ no matter how large (but still finite) the number of steps are. But as soon as the number of steps becomes infinite, the rule does not hold and hence the straight line segment AB has a length which is not equal to $a+b$ (but in fact less than $a+b$).

2. Catching a Thief

Often, in everyday life, we get indirect information about a variety of things. For example, if a thief steals something and escapes, then police may not learn his name and address directly. Instead, they may get many other small bits of information about the thief. For instance, that he was a tall, fair looking person, or that he was a strong and stout man, etc. Each piece of information thus received brings the police closer and closer to the thief.

This is also true of Mathematics. We often encounter problems where one has to catch the answer hidden in the various pieces of indirect information. For example, instead of telling you directly the number of oranges there are in a store-room, you are told that in the heap 1000 oranges are not good, that 50% of the remaining have been sold and that leaves 3000 oranges. Then one has to find the total number of oranges.

We solve such problems either as a part of our daily work or sometimes we think of them as puzzles for entertainment. Someone not

conversant with formal mathematics uses a trial and error method for solving such problems. But a mathematician employs a powerful tool in the solution of such problems. This tool is called an equation. You may wonder what this equation is like. Well, these equations, surprisingly resemble our political parties in many respects. Any political party usually pretends to know the answer of peoples' problems. Similarly an equation begins its task by pretending to know the final answer, saying it is X. Now, a political party has its own election symbol such as a lotus or an elephant. So also, an equation has its own symbol which is $=$ (two horizontal line segments). Finally, a political party usually says that it treats rich and poor, literate and illiterate, etc., equally or in other words it is impartial. So also, an equation proceeds on this principle of impartiality, i.e., it always gives identical treatment to its left and right side, i.e., if you divide its right side by 5 then you will have to divide its left side also by 5. If we add 7 to the right side of an equation then we will have to add 7 to its left side too. Using, this principle one can easily solve an equation such as $3x+12=15$. While solving a quadratic equation such as $x^2+5x+6=0$, one essentially tries to reduce it to two simple equations $x+3=0$ and $x+2=0$. These equations now can be solved by using the impartiality principle. Even in the solution of simultaneous equations such as $x+y=5$, $x-4=3$, one tries to reduce them to two simple equations $2x=8$ and $2y=2$ which one can solve by using the impartiality principle.

With this much information about the working of equations, let us now turn to a few interesting puzzles recorded in the history of Mathematics. Greek Anthology, Leonardo of Pisa's Liber abaci and Pacioli's Summa give such problems. We will consider here two problems from Anthology and one problem related to the life story of Diophantus who is called the father of Algebra.

(1) *Euclid's riddle*: A riddle attributed to Euclid and contained in the Anthology is as follows.

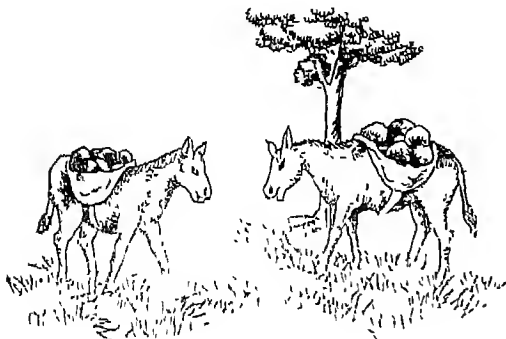


Fig. 1

A mule and a donkey were walking along laden with corn. The mule says to the donkey, if you gave me one measure I should carry twice as much as you. If I gave you one, we should both carry equal burdens. Tell me their burdens, most learned master of geometry.

Solution: Let the burden carried by the mule be x , and let the burden carried by the donkey be y . Then from the given condition

$$(x+1)=2(y-1) \quad \dots (1)$$

$$\text{and } (x-1)=(y+1) \quad \dots (2)$$

starting with equation (1)

$$x+1=2y-2$$

Take out 1 from both sides.

$$\therefore x=2y-3 \quad \dots (3)$$

Adding 1 to both sides of equation (2)

$$\text{We get } x=y+2 \quad \dots (4)$$

From equations (3) and (4) we can say that

$$2y-3=y+2 \quad \therefore \text{ (each being equal to } x)$$

Now adding 3 to both sides we get

$$2y=y+5$$

Taking out y from both sides gives

$$y=5$$

But from equation (2) $x-1=y+1$

$$\text{i.e. } x-1=5+1$$

$$\text{or } x-1=6$$

$$\text{or } x=7$$

Thus the burden of the mule was 7 units and the burden of the donkey was 5 units.

$$\text{Tally : } (7-1)=5+1$$

$$\text{and } (7+1)=2(5-1)$$

(2) *Diophantus' riddle*: In the twilight of the Greek era, Diophantus appeared. Though we do not know the exact period in which he lived, we do know how long he lived. We have this information because one of his admirers described his life in the form of an algebraic riddle. It says.

1. Diophantus' youth lasted $1/6$ of his life
2. He grew a beard after $1/12$ more
3. After $1/7$ more of his life Diophantus married.
4. Five years later he had a son.
5. The son lived exactly $1/2$ as long as his father and Diophantus died just four years after his son. How long did Diophantus live?

Solution: Let us suppose that he lived for x years.

Hence (i) His youth was $\frac{x}{6}$

(ii) He grew a beard when $\frac{x}{6} + \frac{x}{12}$ years old.

(iii) He married when he was $\frac{x}{6} + \frac{x}{12} + \frac{x}{7}$ years old.

(iv) He had a son when he was $\frac{x}{6} +$

$$\frac{x}{12} + \frac{x}{7} + 5 \text{ years old.}$$

$$\text{or } 9 = \frac{(84-14-7-12-42)x}{84}$$

(v) His son lived $\frac{x}{2}$ years. Thus when

$$\text{or } 9 = \frac{9x}{84}$$

his son died Diophantus was

$$\frac{x}{6} + \frac{x}{12} + \frac{x}{7} + 5 + \frac{x}{2} \text{ years old}$$

Multiplying both sides by $\frac{84}{9}$ we get

(vi) He died 4 years after his son.

$$\frac{(9)(84)}{9} = x.$$

Hence when he died he was $\frac{x}{6} +$

$$\text{or } x = 84$$

$$\frac{x}{12} + \frac{x}{7} + 5 + \frac{x}{2} + 4 \text{ years old.}$$

(vii) But he lived for x years.

$$\left(\frac{x}{6} + \frac{x}{12} + \frac{x}{7} + 5 + \frac{x}{2} + 4 \right) = x$$

$$\therefore 5 + 4 = x - \frac{x}{6} - \frac{x}{12} - \frac{x}{7} - \frac{x}{2}$$

Thus Diophantus must have lived for 84 years. Diophantus is called the Father of Algebra because he was the first to abbreviate expression of thoughts with symbols of his own and also because he could solve Indeterminate equations. That is why such equations are often called Diophantine equations.

The Magnetic Guide and its Contribution

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It is by virtue of inherent permanent magnetism present in animals that they are able to detect celestial magnetic field. Biologically synthesised permanent magnets in the form of magnetite iron ore "lodestone" (FeO , Fe_2O_3) were first discovered. After this discovery, permanent magnetism was detected in many animals ranging from micro-organism to mammals. Many species of magnetotactic bacteria are known to possess crystals of magnetite.

It seems to be surprising but true that the animals are able to get information on direction-location and time from the celestial sources of the magnetic field. Such information is useful particularly when guides like sunrise or sun-set are not available to them. Among natural sources, though static, the earth considered to be the gigantic field is the chief source of magnetic field.

The animals with magnetic sense exploit the circadian variations of celestial magnetic

field as a tool of their information-processing strategies. There are said to be four ways employed by magnetic animals to detect natural magnetic fields namely induction, permanent magnetism, para-magnetism and super-paramagnetism. It is by virtue of inherent permanent magnetism present in animals that they are able to detect celestial magnetic field. Biologically synthesised permanent magnets in the form of magnetite iron ore "lodestone" (FeO , Fe_2O_3) were first discovered. After this discovery, permanent magnetism was detected in many animals ranging from micro-organism to mammals. Many species of magnetotactic bacteria are known to possess crystals of magnetite.

Magnetite is the densest substance known to be synthesised by organisms even. Among mammals, wood mice, bats and dolphins are reported to possess magnetite.

Invertebrates and Magnetic Sense

Among the invertebrates, honey-bees are of special interest as far as the magnetic sense is concerned. Permanent magnetic crystals of magnetite have been found in the abdomens of honey-bees. These crystals appear during the pupal stage when no food is ingested and therefore are of biological origin. Magnetic crystals containing cells in the abdomen are closely associated with the nervous system. The behavioural patterns of honey-bees provide a suitable example of their directional sensitivity. Hundreds of worker bees cooperate to build several parallel sheets of honey comb in almost total darkness. This means, obviously, that honey bees agree regarding the orientation of the honey comb in advance.

Bees perform dances in the hive itself. These dances normally take place in the vertical sheets of the comb. A vertical sheet helps us in indicating the sun's azimuth, the angle of a dance which corresponds to the angle of the sun and the source of food. Since the dance is performed by returning worker-bees, it probably

communicates information regarding the distance and the direction in which the food they have discovered is available. In addition to finding direction, the honey-bees are able to receive information concerning time on the basis of their magnetic sense.

Birds and Magnetic Sense

Magnetic location sense is reported to be in pigeons and other many migratory birds which use magnetite to determine their directions. Pigeons possess localised concentration of crystal magnetite in bone-cavities near the mid line, roughly between the olfactory bulb and the neck muscles. Airplane tracking by pigeons and their ability to locate their own houses when deprived of vision speak of their magnetic

sense of location. After detecting natural magnetic fields by induction, permanent magnetism, paramagnetism or super-paramagnetism, the animals with compass sense transform this information into a form which later on provides them direction, location and time sense. Magnetite has been discovered in fishes and reptiles too. Behaviour of sharks and rays reveals that they respond to celestial magnetic field by a method of induction. Paramagnetism is rarely employed as a method of detection of natural circadian variations of natural magnetic field. Honey-bees are the only animals which are believed to employ super-paramagnetism. Whatever information available on the magnetic sense of the animals is more or less based on their behavioural sense.

Development of Science Education Equipment : A Close Link with Curriculum, Texts and Print Media—A Systems Approach

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After the Second World War, all the disciplines of science and technology have advanced with a rocketting speed and their knowledge is expanding exponentially to double in volume in a decade. This pace is going to be more in the years to come. New concepts and devices are discovered every day. Society and time demand the inclusion of these in educational curricula.

I. Introduction

Technical and economic capabilities of a nation are dependent on its national resources and its ability to exploit them. Technical capability is a function of standard, efficiency and adaptability of the education and training systems prevalent. Educational systems all over the world are owned, financed and

controlled either directly or indirectly by the government of that country. This phenomenon is common to both the developed as well the developing countries. Educational systems are subsystems of the societal system. Therefore, the allocation of financial, technological, physical and other resources to education is determined after considering the needs and expectations of the population. Improvement in the quality of education has been one of the major concerns of all in general and that of educational authorities in particular.

After the Second World War, all the disciplines of science and technology have advanced with a rocketting speed and their knowledge is expanding exponentially to double in volume in a decade. This pace is going to be more in the years to come. New concepts and devices are discovered every day. Society and time demand the inclusion of these in educational curricula. Secondly, a need has been felt to impart a kind of education which would promote growth and development of the country in the fields of science, technology and agriculture besides meeting the target of universalization of primary education by 1990, for which educational facilities are expanding with an appreciable pace. Educational systems dealing with undergraduate and higher education have responded favourably and produced scientists, engineers, technologists and medicine practitioners of international standards and repute besides meeting the diverse needs of scientific and technical personnel of the country. (At school education level new curricula in general education and science education in particular have been developed. These new curricula of science education are 'activities-based' and have an increased integration of disciplines as well as those of theoretical and practical lessons. This started changing the mode of teaching-learning from 'chalk and talk' to 'seeing and doing', although number of schemes have been taken up for improvement of science education at school level.) The efforts have been mainly concentrated on improvement of textbooks,

teacher guides, revision of syllabi, strengthening of library facilities, organizing short term refresher and enrichment courses for in-service teachers and not much attention has been paid to strengthening of equipment facilities so as to make science education 'really activities based'

Most of the educators find it much easier to explain a scientific principle through 'oral and printed words' as there are very few who are familiar with the construction and use of the equipment. Teaching-learning will be much more effective if an 'appropriate and proper mix' of curriculum, equipment and textual materials is fed to the classroom. Whether this 'mix' should have interactions before they are put into classroom or later on? What is the stage at which they are to be mixed? In what proportions they need to be mixed? These are some of the many issues which require considerations. Before going into these issues let us know the context in which these terms have been used.

*Curriculum Development*¹ The process of organizing, combining and coordinating the various courses which form the curriculum so that they lead to different levels of knowledge and qualifications. Such a process also includes experimentation, the evaluation of content and of effectiveness, as well as the selection of appropriate teaching and learning methods and materials

*Equipment*² This term is taken to be all embracing and covering any piece of material used in an instructional situation. The meaning ranges from the very concrete example of a very sophisticated piece of apparatus such as a microscope to simple items such as rubber bands, clips, paper, etc used to illustrate various principles. In both cases, the microscope and the various items are "equipment"

*Textual Materials*³ This term denotes a systematic organization and presentation of selected and summarised instructional material,

based on the prescribed syllabus, keeping in view the needs and interests of pupils, to facilitate teaching learning, for the accomplishment of the desired goals of the subject for a particular class

II Type and Need of Equipment

In the past, science education was imparted through 'oral and printed words, and a bit of experimentation. Experiments were performed to prove the theories and match the result with the 'ideal values'. The experiments in physics included measurement of physical quantities such as density, focal length, velocities of light and sound, acceleration due to gravity, resistance of a conductor etc while chemistry confined itself to finding out the quantities and identification of the unknown substances in samples. Mathematics had very little experimentation and was taught through imagination and the same trend still continues. Biology was taught more through classification of families of plants and animals, observations and a bit of experimentation. All these experimentation further confined to the 'teacher-demonstration' activities. Coming to the type of equipment, they were normally the discarded research, or industrial equipment or were modified to teach science but they had the link and background of research and industrial thinking. In most of the developing countries not much of teaching aid and equipment existed and a culture of teaching through 'oral and printed words' has come to stay, hence there are not many teachers who are really familiar with the need, purpose and effective use of teaching aids and equipment. Now, the need has been felt to change these traditional methods and the ball has started rolling and has really picked up some momentum

One of the major objectives of new curricula of science education has been to make it 'activities-based' through 'real-life' problem-solving approach as encountered in daily life. But not

much has been done on teaching aids and equipment fronts and hence imparting of much of the instructions still revolves around 'chalk and talk', 'oral and printed words' and 'teacher-demonstrations'. To change this, development and production of good and effective school equipment has to be taken up in all seriousness. This calls for a lot of demands on financial, technological, physical and human resources. It is not an easy task for any country, especially developing ones to meet these demands of equipment and teaching aids of all the schools of the country. No one would differ on having an inexpensive, easily available, simple to work with, easy to make, replace, repair and multipurpose teaching aids and equipment. The term multipurpose has been used in the context of the use of equipment in many fields of scientific activity and equipment of which one part is usable for different purposes. Scales, watches, tapes, meters, balances, tray and laboratory stands etc. belong to first category while test tubes, battery holders, pins, clips, flasks, magnets etc. belong to the second category. But 'student-centred activities' demand either more number of equipment or some adjustments in the schedule of carrying out activities. Adjustments of activities can be seen in the form of group-activities of related concepts so as to reduce the total cost of equipment in a school budget. This will further enhance the use of equipment and thus reduce the 'effective cost' of the equipment.

III. Rationale for Linkage of Equipment with School Set-up

One of the major aims of education is to transmit all those values and knowledge which have been acquired through ages. With the need and pressure of imparting the knowledge of new concepts and devices and to make 'science is doing' successful, there is a gradual transition from education through 'oral and

printed words' to education through demonstrations, practical work in classrooms, activities of students in laboratories and workshops using teaching aids, models and equipment. The relationship among equipment, curriculum and textual materials is that of a closed-loop system. The curriculum and the textual materials have a decisive role to play in the development of a suitable equipment but in turn the equipment has a definite say in the finalization of textual materials and the curriculum. Therefore, in order to achieve the objective of development of a good equipment which has the desired features of inexpensiveness, simplicity, ease of multiplication, easy to work with, ease of replacement and repairs and above all which make teaching-learning effective, enjoyable and activities based, need the cooperation and involvement at the planning level of all those involved in the development of curriculum, equipment, textual materials and the classroom teaching. The nature of equipment plays a very vital role in the process of teaching-learning particularly in science and technology education. An equipment which might have been initially developed to perform an activity, to explain a principle or theory but in practice may also be used by teachers and students for some other activities. Sometimes they could not find its use to achieve the objective for which it was developed. That is, through the passage of time either the equipment may become obsolete, lose its relevance to the curriculum and textual materials or may find its use to perform new activities. This further shows that consultations and interactions among the 'trio' has to be 'on-going' rather than 'one-time'.

The education curricula are getting overcrowded and there is no time to introduce additional subjects in the form of practicals etc., hence 'activities-based' teaching is the only solution. Within the limited time available in a school set-up, pedagogically sound equipment

will drive home the instructions and the concepts involved. Although the curricula and textual materials in science are getting updated but the trends about the equipment continue to follow the traditional approach and equipment relating to electronics, nuclear physics, pollution control and non-conventional sources of energy are still to find their place in a school set-up.

The provision of school equipment requires long term planning as this requires consideration about the content, methods, maintenance, cost, problems with design, production, repairs, spares and distribution etc. Above all, it is the economy which is the controlling factor. The economic situation in the country affects the 'spread of equipment' in schools. It has been observed that it is the education sector of the budget which gets 'the axe' whenever national economy demands. Whenever a new material or equipment is supplied or developed it is very essential that it finds its place in school set-up through teacher training organized by suppliers and designers.

IV How to Get Good Equipment

A. Models for Equipment Development. The importance of inexpensive, good and relevant equipment has been realized throughout the world. Initially, developed countries such as the USSR, the FRG, the UK and the USA and later Hungary, Hongkong, Philippines and India followed a model featuring very close linkages among those involved in the development of curriculum, equipment and textual materials. Some countries have followed a model in which developments of curriculum, textual materials and equipment facilities have been integrated under the banner of Curriculum Development Centre. Actually speaking the 'trio' is a parallel and simultaneous activity with interactions among them. It is unfortunate that most of the educators give lower priority to equipment

development as compared to the other two processes. Although some countries have equipment development facilities but they are considered and taken to be service units mainly to fulfill the needs of the curriculum and textual material developers and the establishment. This is an alarming situation. An equipment finds its place in textual materials to help the teacher in carrying out activities and experiments. Since textual material and curriculum developers are not much familiar with the techniques and tools involved in development, fabrication and production of equipment they may not be able to foresee and appreciate the problems, difficulties and limitations of the equipment development. The equipment that finds place in textual materials may not be easy to fabricate or may be expensive to be acquired either from local market or through imports. But this situation can very well be avoided if the 'trio' work 'hand in hand' to sort out the 'real-life' problems involved at much earlier stages which would lead to working solutions. It will be an ideal thing if the same person carries out all the three activities, but this is not practicable. It therefore demands that the three activities are carried out together. This will eliminate the mismatch of equipment and textual materials and difficulties of non-availability of equipment while the text may be ready. UNESCO, UNDP, UNICEF and the Commonwealth Secretariat provided the leadership in the concept of 'team-work' in the development of curriculum equipment and textual materials. They provided finance, prototype equipment and experts who worked in many developing countries like Afghanistan, Bangladesh, Ethiopia, India, Malaysia, Mozambique, Nigeria, Philippines, Thailand etc and provided leadership in setting up equipment development centres. They worked for curriculum and textual material development programmes. Hungary realized that a model in which the co-operation of the subject-teacher, the design

technologist, the specialist in school equipment and media specialist is necessary to have the unity of purpose, features and economic factors related to the subject-matter. The committees which bring together the expertise in the textual materials, curriculum and equipment development have started functioning there. All said and done, it is a very well established practice that meeting the requirements of textual materials always plays a decisive role in planning and development of equipment.

In order to have cost effective educational equipment, materials which have not been designed with the purpose of teaching are finding their place, acceptability and use for educational purposes. These include some toys, utensils, hand tools etc. available as domestic, industrial and consumer products.

There are many models for equipment, curriculum and textual material development centres as regards to their interactions. Some of them are as follows :

1. Independent organizations for equipment, curriculum and textual materials development without any interactions among themselves.
2. Equipment development centre, curriculum and textual materials development centres have functional autonomy but integrated at planning level.
3. Preparation of curriculum and textual materials before consulting the equipment development specialists.
4. Fabrication of equipment without having a close interaction with specialists in the field of development of curriculum and the textual materials

All these models are functioning at one place or the other on the globe and every model has some strong points and deficiencies. On the basis of the feedback and various published reports we can say that none of the models is 'the ideal'.

B. Reaching and Getting the Equipment : It has been an observed fact and a reality that in a school set-up science equipment has a 'step-motherly' place as compared to the textual materials. This attitude needs change.

In most of the countries the equipment is to be provided by a centralized agency and hence a central effort is a must. If it has been accepted in principle to provide science equipment to schools then a 'master list' of all the necessary teaching aids and equipment be brought out through deliberations among curriculum, textual material, equipment specialists, subject teachers and educational financing agencies. The equipment of masterlist can be categorized into three categories. They could be procured through the following sources :

- (a) Imports
- (b) In-house development and
- (c) Local market

Imports put a lot of strain on country's exchequer because the number of equipment required will be large and developing countries barring oil-rich nations and a few others cannot really meet the bill. Second problem will be regarding spares, repairs and maintenance of such equipment. Although some advanced countries in the name of aid or donation provide some equipment but it may be very well planned trap and such proposals need very careful scrutiny. The leadtime and import formalities will be the impeding factors, besides having a dampening effect on the development and growth of indigenous technology and industry. Hence, this mode of procurement does not appear to be practically economical in the long range. The other modes are the procurement from local market and in-house development. This consists of first exploring the local market and procuring materials which are available either for teaching purposes or for other purposes such as industrial, domestic, games or waste material etc. Then comes the

in-house development which is the 'real-solution' when we have to meet the demand of a very large number of schools with diverse equipment. This step is a follow up of development and standardization of equipment. In all programmes concerning curriculum and textual materials development and in-service teacher training it is invariably mentioned that the teachers and students will use locally available inexpensive and waste materials for the development of some teaching aids. In reality, this 'theoretical concept' remains in 'programme' but rarely gets implemented in 'practice' since fabrication of equipment and teaching aids would require knowledge of raw materials, skills and competencies of handling tools with some basic facilities of a workshop, only in a very-very few cases this type of equipment development does really take place. Several countries like GDR, Pakistan and Philippines etc. have set up equipment development centres at the national level. These countries are assembling and procuring parts and equipment from local market through their very well developed industrial base. They are distributing equipment to the schools through different administrative mechanisms peculiar to each country. In-house development needs the knowledge, skill and competencies of a design and development engineer. The engineer requires to be well versed with the materials involved and the physical facilities should include metal cutting, electroplating, electrical and electronics, hot and cold metal working, plastics, glass, wood working and painting shops with a good back-up of stores-purchase and inspection and quality assurance sections. Development and production need to work entirely as separate entities with technical consultations wherever required, since these two processes are quite different and require different skills, facilities and knowledge. Development caters to the needs of few pieces of equipment while production volume comes

to hundreds or some times thousands. A need has been felt to establish an agency to standardize, certify the quality, suitability and safety norms about the equipment before it is sent to schools or licensed for multiplication. This will help in minimizing the problems of repairs, maintenance and non-availability of spare parts. The engineer, curriculum and textual material expert should have close links at all stages of development particularly at the stage when in-house prototype is being made ready and then when the product and its manual is under finalization.

One of the most important stages of in-house development of equipment is the initial testing stage of curriculum and textual materials i.e. "engagement phase" so as to evaluate the purpose and usefulness of the curriculum and textual materials in association with developed equipment; then comes the final stage "the marriage" phase.

It has been found that due to lack of career growth in school equipment field neither many technical personnel are available nor get attracted to this. To create a healthy climate and motivate them some efforts such as fellowships, exchange programmes and secondment etc. be started and schemes be launched to retain the personnel engaged in this area. It will be worth trying to select and train some technicians and science-based personnel who have aptitude for development and production of equipment. The training may cover the entire technical gamut of a typical school set-up such as maintenance of classroom and laboratory furniture, the school building and the equipment. In a country like ours this need can be fulfilled by establishing a National Centre for Development of School Equipment (NCDSE) coupled with four Regional Centres which could have close-coordination with States and would adopt its programme of equipment development as per regional requirements in accordance with the local needs with

due considerations to the availability of raw materials, skills and facilities.

V Role of Media in Development of Equipment

Another most important aspect of equipment design is the information flow and communication among equipment designers, producers, suppliers, educational administrators, planners and the users. There are many aspects of school equipment design and particularly in science, applied science and technology education which require information flow at all stages of sub-system levels of school education, besides outside the system. An appropriate network and proper information flow in equipment design can considerably bring down the effective cost of the equipment through "value analysis" in the context of new and inexpensive materials and components by updating the tooling and 'tuning the product'. Information regarding the "master list" (minimum requirement) of equipment in a typical school set-up, their sources of availability, spares and repairs facilities need to be given wide publicity. This will reduce the downtime of the equipment thereby increasing their use, life span and reduction in effective cost.

The equipment designers, producers, and suppliers are required to be familiar with the needs of science teachers and educators. The needs include instructional manual and training specifications. The information regarding the rate of failures at component and sub-system levels and that of equipment besides their reliability, identification of critical components and observations and feedback about their utility will be useful for the designers. The equipment designers also need to know new curricula, trends and strategies in teaching-learning at classroom and teacher training levels so as to launch the equipment development programme or to tune their tooling with current environment and get pre-

pared for meeting the anticipated requirements of equipment.

Information flow and communication from and to science teachers is another important aspect for making equipment more useful. At many places the teacher is afraid of using the equipment for the fear of any breakage, which may be made up from his salary or he may be penalized for that. The teacher uses the equipment only when he finds that senior education officials or some VIPs are visiting the school. Hence a campaign for "removal of the dust and rust" could possibly improve the situation. Further, suppliers and manufacturers normally do not respond to the communications of science teachers, once the equipment has been sold and payments have been received by them. Many a time their equipment do not function as claimed at the time of sale or as advertized. Hence launching of a consumer right awareness programme could be a good idea. Timely and neutral briefs and reviews about new and innovative equipment may help the teacher to decide or offer comments about the purchase of the equipment. The teacher could also be educated that the equipment is a multipurpose device, i.e. many other activities could be performed or it can also be used for teaching some other principles and theories.

All these problems for solutions and many others could be approached through a 'print media' by publishing newsletters, bulletin or journals. Perhaps, starting a bulletin entitled "SEED" i.e. "School Education Equipment Development" may be good beginning to bridge the gap between the idea, equipment, designers, producers, suppliers, administrators and users. To my information, there is no publication in our country which caters to the field of school equipment. Although Science Reporter⁴ and School Science⁵ publish articles and papers on and about equipment but these are not regular features. The cause of

"spread of equipment" needs attention and regular features under the titles, "You Can Do It", "Equipment and School", "Equipment Idea, Product and Profile", "Circuit Ideals For Fabrication" and "Trends in School Equipment" be considered in School Science besides associating a knowledgeable expert of this field in the editorial board of this and such other publications

VI Conclusions

There exists a disparity in the importance of curriculum, textual materials and equipment development programmes. This imbalance needs correction by providing a judicious and proper mix in their development through 'on-going' continuous interactions among equipment experts, curriculum and textual materials developers, subject-teachers and media experts so as to integrate activities with the texts. Establishment of an agency at national level for standardizing, providing quality assurance,

suitability and enforcing the safety norms in school equipment will go a long way. Further, these equipments should find their place in the textual materials. For a country of our size a National Centre for Equipment Development is not enough and four Regional Centres with almost similar facilities as at National Centre would be an ideal thing. In order to have inexpensive, simple, easy to produce and simple to use, repairable and above all not to lose the relevance of equipment to textual materials, it is essential to have very well-defined coordination and interaction amongst the 'trio' i.e. the curriculum, the equipment and the textual material development experts. Importance of information flow regarding ideas, trends, product profile, standardization of school equipment amongst teachers, teacher training institutions, industry and business requires attention and could be met through the use of existing journals and by starting a bulletin entitled "SEED" "School Education Equipment Development".

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Species Under Threat

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There are about 3.5 million living species on our earth, out of which the existence of about 0.7 million has been threatened in the present-day life of science and technology. More than one species per hour of our fellow creatures are disappearing daily from the face of the earth.

Scientific and technological developments have helped us to a great extent on one hand and disturbed the nature on the other. Man has exploited all living species for his economic and recreational purposes without following natural laws. Our anti-natural activities will be responsible for the disappearance of about 20% of total living species from this planet in coming 20 years. Every living species has a specific role to play in nature and his absence creates an imbalance in the environment by affecting other species. The species under threat cover various flowering plants including trees and animals like elephant, rhinoceros, whale, tiger, zebra, pigeon, parrot, etc. This problem of extinction has compelled us to

think and search ways to solve it, before it touches human himself. Author of this paper tries to describe the various factors responsible for the extinction, importance of some threatened species and efforts being made to check further extinction at various levels of human organisations

Introduction

There are about 3.5 million living species on our earth, out of which the existence of about 0.7 million has been threatened in the present-day life of science and technology. More than one species per hour of our fellow creatures are disappearing daily from the face of the earth. Man, who is the monarch of external world, is a slave of his inner world of emotion and passions to a greater degree. The artificial tools and weapons helped man in developing over-confidence and self-pride. Technological developments give us power and not values of life, like to live in harmony with nature. Now, even human species (*Homo sapiens*) is facing extinction due to his own activities including production and testing of nuclear weapons. Nuclear wars cannot be won and will destroy life from this planet.

Causes of Extinction

This planet embraces innumerable life forms, living in air, water and soil, from billions of years. The balance in environment is the result of natural evolution since origin of life. The birth and death of organisms, their life systems, diseases, inter-relationships with natural phenomenon like earthquake, lightning and erosion has established a complex of nature. It provides an equilibrium between livings and non-livings maintained through natural selection. Human is a product of evolution and natural environment, even then he has created an environment through cultural evolution by defying the forces of natural selection. Today, we are witnessing an in-

crease in flooded area, deserts and soil erosion, genetic damages to living systems, hazards from excessive fertilizers, pesticides, drugs, smokes and nuclear explosions, deforestation and various types of pollutions. All these are threatening the existence of life on the earth.

Some examples to illustrate the magnitude of the problem can be cited. At present the trees are being felled at the rate of 14 hectares per minute. In East Africa alone about 70,000 elephants are being killed annually. The number of black rhinoceros has reduced to 1/10 in ten years (100,000 to 10,000). About 5,000 walrus are being killed annually for ivory in Arctic regions. Cheetah is almost extinct due to its skin utility in ladies coat. Zebra skin is used in drums, so they are being killed at the rate of 10,000 annually.

Importance of Threatened Species

We cannot deny the importance of plants for us. We get pure gas (oxygen) for our survival from plants besides food materials. We know that plants can live without us but we cannot live without plants. It can be further illustrated with the examples of trees. Trees are useful in the production of oxygen, control of air pollution and soil erosion, maintenance of soil fertility, recycling of water and control of humidity, shelter for animals and birds and in protein conversion. A tree of about 50 tonnes weight renders the services, valued at about two million rupees, besides the timber, fruits and flowers in a life span of 50 years. To build one tonne of timber in tree about 15 tonnes of harmful carbon-dioxide gas is absorbed and one tonne of useful oxygen gas is released. The importance of animals under threat can be emphasised by citing some examples. Turkey vulture (*Cathartes aura*) is an anti-pollutant environmental controller. It feeds on dead animals and works as scavenger. This helps in eliminating the spread of diseases

among other animals. The head of this big bird is without feather and ultraviolet rays can easily enter the skin so as to keep off microscopic parasites that it might have picked up from dead bodies. The cost of one elephant tusk may value up to Rs. 3,600,000/-. The sprouting horns of black rhinoceros may price at the rate of Rs. 300,000/- per kilogram. A leopard may cost up to Rs. 100,000/-. Even the parrot bird may cost up to Rs. 60,000/- in western world.

Some of the threatened plants are of great importance in our day-to-day life. About 2200 species of higher plants are at the risk according to Huxley and Leigh (1981) in Australia alone. In India about 1000 species are going to disappear shortly due to our mismanagement and wrong planning. Some species of *Eucalyptus*, *Podocarpus*, *Phyllocladus*, *Agathis* and even *Acacia* are endangered trees from our forests. The species with high medicinal values like *Rauwolfia serpentina*, *Colchicum luteum*, *Diocrea wightii*, *Aconitum demorrhizum* etc are also facing the danger of extinction. Presently about 10% of the total known species of flowering plants are facing threat of extinction due to our own activities. The examples of threatened species among animals are elephant, black rhinoceros, walrus, Cheetah, leopard, tiger, gorilla, zebra, pigeon, parrot, kangaroo, turkey vulture, etc. Even the survival of human species is being threatened by the nuclear weapons. It is not a surprise but a fact that there were about 6 billion passenger pigeons in USA during 1885. Killing of about 1/2 million daily by the hunters, the race has disappeared in 29 years from this planet and last bird died on 1.9.1914 in Ohio Zoo, USA.

Efforts to Check Further Extinction

The newly developed imbalance in nature has compelled human beings to think and work to check further extinction of living species. In

1972 all Heads of the States met together in an UN Conference held in Stockholm and decided to work in this direction. The resolutions concerned with this aspect speak that—'all natural resources of the world must be safeguarded for the benefit of present and future generations and wildlife and its habitat must be conserved'. Most of the countries have established Ministries for Environment, Natural Resources and Conservation.

Several international organisations are working hard in this field. Some of them can be cited as examples: World Wildlife Fund (WWF), International Union for Conservation of Nature and Natural Resources (IUCN), Rare Animal Relief (RARE), New York. Young People Trust for Endangered Species (YPTES), Convention on International Trade in Endangered Species (CITES) and Friends on Earth Trust. There are several publications to create an awareness among the people. The Red Data Books of IUCN, Endangered Species by Friends of Earth Trust, Global 2000 Report from USA and so on. Several Governments have also promulgated various Acts in this regard. The Wildlife Protection Act, Migratory Bird Act, Wild Plant Act, Wildlife (Protection) Act etc were promulgated for the protection of wildlife in the country.

Nowadays, there is a great emphasis on the development of environmental ethics, value systems and living in harmony with nature in our curriculum. The environmental ethics are changing from earlier concept of dominance and continuous progress to respect for all living things and appreciation for the beauty of nature. Various religions also speak about the protection of animals and plants. There is a provision of worship for various natural

resources like trees (Peepal or Bargad, Am, Imli, Mahua); rivers (Ganga, Yamuna), animals (cow, buffalo) and even sun, moon, ocean, clouds etc. in Hindu religion. Jain religion support the idea of equality among all livings including plants, and their killing is considered a sin. Moslems also do not support the killing of animals for food. The holy book of Christians mentions that "our god is the same God, this earth is precious to him, and to harm the earth is to heap contempt on its creator. All things, therefore, that you want others to do to you, you also must likewise do to them" (Mathew 7 : 12). "Man want on almost frivolous destruction of the wild kingdom is a gross abuse of the trust given by God (Genesis 1 : 28). The idea of eco-development, development without destruction is being emphasised greatly.

We must begin with the notion that we must change our attitudes towards the natural environment which envelops us, which nourishes and even composes us. The human ingenuity which has brought technological advances is threatening the life systems responsible for sustaining us. The corporate passion for profits which has made our lives earlier, now threatens to diminish earth's treasury of natural beauty which gives meaning and joy to life. What can be done? The answer, we believe, lies in education—in providing information to the public, so that within another generation, humanity will recognize its role as protector and participant in nature and not conqueror. I believe change begins at the local levels, the societal values and policies change person to person, community to community. Let us start this work without any further delay.

Nutrition Education in the 1980s¹

SVATOPLUK PETRACEK

Today's nutrition education begins by asking what the nutrition problem to be solved is. It begins by going out into the community to find out if the problem is really what those responsible for nutrition education think it is—or if it is something different. Is protein-energy malnutrition a problem? Is vitamin A deficiency a problem? Or is diarrhoeal disease a problem? Which of the problems is amenable to an educational intervention?

The art and science of nutrition education have reached a milestone in their development. Since the early 1980s, growing attention has been paid to improving the effectiveness of nutrition education. Nutrition education has evolved from local teaching and a concern with simple knowledge and information, disseminated primarily on a one-to-one basis in the classroom or clinic, to focus on strategic use of problem-specific messages through various channels of communication.

Nutrition education has become a creative

and challenging discipline whose roots are only partially in nutrition and whose real source of inspiration comes from fields such as the social and behavioural sciences, anthropology, market research and modern communications. The new nutrition education encompasses a whole new vocabulary that includes such terms as "formative research", "message design", "material development" and "media planning". This vocabulary resembles that of development communications more than nutrition. Taken as a whole, these become an array of highly effective techniques for changing nutrition behaviour and practices and, if well done, nutrition and health status too.

Today's nutrition education begins by asking what the nutrition problem to be solved is. It begins by going out into the community to find out if the problem is really what those responsible for nutrition education think it is—or if it is something different. Is protein-energy malnutrition a problem? Is vitamin A deficiency a problem? Or is diarrhoeal disease a problem? Which of the problems is amenable to an educational intervention?

Education alone cannot bring potable water to a community, but it can help reduce the risks of water-borne diarrhoeal diseases.

The new nutrition education begins by identifying individual behaviours and practices that the target audience needs to change and then attempts to detect "resistance points" or problems that the target audience may have in changing former practices. Once having pinpointed these "resistance points", the new nutrition educator then goes out into the community to solicit the community's participation in developing practical solutions that will overcome such resistance. Solutions, once identified, are tested out in the community for their nutritional soundness and their feasibility that is to say, can the community actually carry them out?

This changing nature of nutrition education places greater responsibility on the nutrition educator, who needs to understand the nature

¹ Courtesy: Information File, International Bureau of Education, P.O. Box 199, Geneva 20.

of behavioural practices in target population groups as well as the socio-cultural constraints that inhibit change. The nutrition educator needs to know how to identify new practices that will improve nutrition and health status, particularly those that are acceptable to communities, before designing and implementing an educational strategy to promote desired behavioural change.

The advent of this behaviour-change approach to nutrition education offers tremendously effective techniques for carrying out activities based on real learner needs and desires. Designers of nutrition education of the 1960s and 1970s would apply the same educational programme, technology or solution in all situations. They would specify curriculum and teaching content, number and type of materials needed—often without ever stepping out into the community where their learner audience lived. Those involved in school nutrition education would, for example, when faced with problems as student fatigue, weakness and poor school performance, deliver standard nutrition lessons based on universal messages like “eat more protein”, or “eat more energy rich foods”. Today’s nutrition educator faces the problem differently, accepting no standard recommendation. The feasibility of various solutions is explored, and problems or resistances the local community might have to changing practices and adopting new ones are identified.

The nutrition situation around the world in the 1980s is demanding new approaches to nutrition education. Malnutrition is widespread—several million people suffer from protein-energy malnutrition; hundreds of millions more suffer from vitamin A deficiency, iron deficiency, anemia and iodine deficiency. The human cost of malnutrition in physical and possibly mental retardation, debilitating illness and low-energy levels affecting scholastic performance, productivity and earning

capacity is awesome. The effects of malnutrition are particularly prevalent among children.

If we want to lower infant and child mortality, improve child survival and raise a generation of children free from malnutrition and its deleterious effects on physical, mental and cognitive development, serious and sustained efforts are needed to improve nutrition education and the quality of teaching and learning to ensure that people learn about, believe in and adopt a relatively narrow, but absolutely critical, set of new beliefs and skills that will reduce mortality and morbidity, while increasing the quality of child survival.

Behaviour Change Approach : the Application of Social Marketing

Perhaps one of the most effective of the new approaches to nutrition education in the 1980s involves the application of *social marketing principles and techniques*. The term “social marketing” was coined a little over ten years ago by civic-minded members of the marketing, mass media and advertising professions. It was intended to refer to activities that applied principles of modern marketing, commercial advertising and broadcast media to the pursuit of social goals.

In more recent years, the types of activities that have been referred to as “social marketing” have expanded and now include a range of skills derived from the social and behavioural sciences, anthropology and ethnography, non-formal education, curriculum design and public administration. Skills borrowed from these various fields include: concept testing; focus-group interviews; target-audience segmentation; target-group analysis; message design and testing; materials development, educational strategy; and media planning. The social marketing approach to nutrition education emphasizes understanding the group of people—the learner audience to be addressed—and carefully designed educational

messages to promote new behaviours that have been tested out for their nutritional soundness, "do-ability" and acceptability by the target audience

Social marketing is the adaptation of marketing (itself a neutral methodology) to the solution of public health problems. The difference between "social marketing" and "marketing" is in *substance* and *objective*, not methodology. Social marketing of nutrition, for example, should not be confused with the product marketing of a commercial company which markets foodstuffs for profit. The goal of social marketing-oriented nutrition projects or programmes is people's nutritional health.

During the last decade, social marketing has been effectively used for family planning. Social marketing-oriented family planning programmes are characterized by their good adaptation to target audience behaviours and practices, and local conditions, in addition to their solid management. Social marketing of nutrition and health has only come into being since the late 1970s/early 1980s, yet, despite this short time, a number of countries have organized and carried out very effective educational campaigns that have altered nutrition and health-related behaviours and improved the nutritional health status of target population groups.

Recent Successful Non-formal Nutrition Education Interventions

In the developing world, a number of projects are worth mentioning

The *Indonesian Nutrition Communications and Behaviour Change Project* has succeeded in demonstrating on a fairly large scale that education alone—without the provision of supplementary food—could improve the situation of nutritionally "high risk" target groups.

The Indonesian project effectively applied

social marketing principles to non-formal education. It relied on carefully constructed messages designed to promote new nutrition behaviours that had been well tested among the target audience. Villagers were involved in the preparatory inquiries into nutritional and health problems. Project designers worked hand-in-hand with villagers in identifying particular problems, and in proposing and testing solutions. Villagers contributed to decisions about nutritional messages, educational materials and the way these materials were used for instruction. These messages and materials were then transmitted through multiple channels of communication, including village-level nutrition educators, the rural press and local radio.

Another unique feature of the project was the way that the community nutrition educators were trained to focus on priority nutrition issues, and thus to minimize all extraneous factors and information.

The project's evaluation found that children in the target area had grown significantly better than children in the control area. Furthermore, the food intake of children in the target area was also greater, reflecting a newly acquired ability of mothers to make better use of family foods for feeding young children.

Success of the Indonesian project can be attributed to the careful application of a social marketing approach to construct messages and materials that were behaviour-specific, practical and acceptable enough for rural mothers to put to everyday use.

In the *Gambia and Honduras*, social marketing nutrition/health education campaigns have been underway to teach families how to prepare and administer oral rehydration fluids to treat diarrhoeal disease. Different educational strategies have been developed for each country. In the Gambia, emphasis has been placed on a set of colour-coded pictorial mixing instructions for audiences who were unable

to read and write, while in Honduras, the programme relied heavily on a combination of printed materials combined with instruction on the local radio

In the late 1970s, *Honduras* reported that nearly one-quarter of all infant deaths resulted from dehydration due to diarrhoeal disease—diarrhoeal disease being the single greatest cause of infant mortality. The Honduran educational intervention thus focussed on those most "at risk" children under 5. After extensive social marketing research, an educational strategy using mass media combined with systematic training programmes for village workers focussed on teaching village mothers about oral rehydration therapy and how they could use it at home. Results of the project have been dramatic; deaths resulting from diarrhoeal dehydration among children dropped by 40% during the first year and a half of project implementation.

In the Gambia, after the first year of the educational programme, two-thirds of the mothers in the target area already had a good understanding of and were beginning to use oral rehydration therapy.

These significant increases in awareness and knowledge of oral rehydration therapy in a relatively short time in both countries were attributed to the systematic use of social marketing techniques and the effective use of interpersonal and mass communications.

The *Brazilian National Breastfeeding Education Programme*, carried out since 1981 by the National Institute of Nutrition of Brazil with UNICEF assistance, is a leading example of a successful educational promotion programme. One of the reasons for the success of this education intervention has been a series of well-researched and well-designed public service announcements carried by national television networks. These sixty-second television spots, featuring leading Brazilian sports and entertainment personalities, reached an

audience of over 50 million viewers. A key factor contributing to the success of this campaign has been the creation and organization of community-based, mother-support groups which provide important face-to-face education and interpersonal contact with mothers wanting to nurse their babies.

In the industrialized countries too, there are a number of examples of successful nutrition/health projects which have taken a social marketing approach and their success can be attributed to effective application of social marketing principles.

In *North America*, the United States High Blood Pressure Education Programme has been in existence since 1972 and makes use of social marketing techniques for mass media promotion coupled with face-to-face education at the workplace. A striking result of this educational programme has been the significant increase in awareness among those suffering from hypertension to keep their blood pressure under control. Furthermore, there has been a strong correlation between this programme and a decline in stroke deaths. Stroke deaths began declining at a remarkable rate since the inception of the programme, dropping by almost half.

What all these successful projects have in common is:

1. They all stress education (along with modern communication techniques) as a major intervening factor in the promotion of new behaviours and practices.
2. In every case, *the approach to education is comprehensive and systematic* and relies on a complex of methodologies drawn from the fields of modern marketing, advertising, social and behavioural sciences, and applied education.

Nutrition education in recent years has been transformed. No longer is nutrition education confined to activities in classroom

or clinic, such as lectures on food groups, or the development of an audiovisual presentation. Although these traditional micro-level nutrition/health education activities are still extremely worthwhile, practical nutrition education today has come to mean much more

Nutrition Education Through the School A New Approach

One of the greatest challenges facing nutrition education is to develop more effective ways of communicating nutrition concepts and practices through formal education. School systems are proving inadequate everywhere, overcome by budgetary restrictions and assaulted by dissonant educational messages from outside the classroom. School curricula are increasingly overloaded, while the mass media are pre-empting a major share of children's attention and intellectual energy. Around the world, Ministries of Education are struggling with such problems and issues affecting the quality of education.

An innovative school-based nutrition education project in the Caribbean is now in the process of developing a model for incorporating social marketing principles into the design of formal nutrition education.

In *Jamaica* a collaborative project involves the Ministry of Education, the International Nutrition Communication Service of the Education Development Centre, Unesco and the United States Agency for International Development. The social marketing-oriented primary school nutrition education project is attempting to incorporate nutrition concepts into the language curriculum of the primary school in order to determine whether primary school children can increase their nutrition knowledge and understanding at the same time as their reading skills. This project has involved a participatory process whereby teachers, parents, resource persons and the Ministry of

Education develop locally relevant nutrition teaching/learning materials

During the first phase of the project, research was carried out to measure primary school students' reading abilities and knowledge of nutrition. This baseline formative research provided clues to the messages and information that should be included in the curriculum design. It also served as a pre-test against which a change in knowledge and reading ability could be measured at the end of the project.

During the initial research, the *reading component* focussed on word recognition, structural analysis (synonym/word definition) and reading comprehension, while the *nutrition component* examined students' awareness of general food-related issues and concepts, including specific knowledge of the values and function of certain foods.

Research findings indicated that, in terms of nutritional messages, the curriculum should place emphasis on: (a) how different foods affect the body, (b) the concept of mixing a variety of foods for balanced meals; and (c) the concept of food substitution (i.e. using plant protein sources as substitutes for animal proteins).

The second phase of the project involved materials development. A community workshop was organized for teachers, parents and resource persons to develop educational materials. Participants provided their ideas and suggestions as to the content and design of the materials. A series of learning activities were also prepared that could be carried out by children themselves to improve their understanding and practice of better eating habits.

This community-based approach to the design of educational materials minimized the usual "top-down" way of providing curriculum and teaching materials to teachers. Teachers and parents were directly implicated in the design of the educational materials.

After the community workshop, educational

materials were further refined by a group of Ministry of Education personnel, including curriculum developers, writers, artists and technical resources persons. Prototype materials were then further adapted based on comments from reading and education specialists, nutrition educators and children's book designers. A prototype student workbook, teachers' guide and supplementary materials were prepared. "Nutrition magicians" was the theme chosen for the educational package, implying that children could become nutrition magicians, that is to say that they were capable of improving their own health by following the nutrition behaviour presented in the manual.

The student workbook incorporated both relatively simple, highly visual reading materials, and more abstract, print-centred stories, poems and essays. Each section introduced nutrition-related vocabulary, and included a series of questions and student-centred exercises. This workbook accommodated a broad range of reading abilities and the project evaluation assessed the degree to which different reading formats were comprehended.

Materials were pre-tested with students in order to check: (a) comprehension for the story's message; (b) clarity of stories and illustrations; (c) interest provoked by pictures and stories; (d) likes and dislikes of certain aspects of the materials; (e) ease of reading and appropriateness of reading level, and (f) relevance of the nutrition-related behaviour that was being promoted.

Children's feedback provided valuable insights for further refining materials, adjusting some of the illustrations and sequencing the cartoon sections. It also became apparent from students' reactions that teachers needed more information in the packages in order to be better prepared to address certain nutrition-related questions and beliefs.

Use of the educational package is now

being monitored in order to determine how well teachers are adapting the lessons, and how well children are reacting and what improvement could be made. A summative evaluation will be carried out at the end of the project to assess the extent to which students' reading abilities and nutritional knowledge have improved. A dissemination meeting will then be held to discuss lessons learned, to receive teachers' feedback and recommendations, and plan for the promotion of the project throughout Jamaica.

An important lesson already learned, of critical importance to other curriculum development projects, relates to the necessity of gathering solid, qualitative information on dietary practices, attitudes and behaviours of the target learner audience. This information is needed to serve as a basis for developing clear, relevant educational and motivational messages for instructional materials.

The Jamaica primary school nutrition education project represents an innovative way in which nutrition education can be effectively incorporated into an existing school curriculum and serves as a good example of how the social marketing approach can be applied to school-based nutrition education. This approach to primary school nutrition education is an alternative to the more complex traditional process of developing separate nutrition courses that require resources and time that are for the most part not available to curriculum planners and teachers.

Nutrition education in the 1980s is a new discipline with a new set of priorities. There is a growing commitment to the systematic use of skills from a range of fields including anthropology, communications, marketing and social behavioural sciences. There are now a number of successful experiences to serve as precedents and models for countries to follow and build upon.

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How Good Are You in Science ?

1. Motion of artificial earth satellite around the earth is powered by .
(A) atomic energy (B) liquid fuel (C) solar batteries (D) earth's gravity.
2. A 'black hole' is an astronomical body which emits
(A) radiation only in the microwave region.
(B) radiation only in the visible region.
(C) radiation both in visible and microwave regions.
(D) no radiation at all
3. Radioactive minerals emit radiations which affect the photographic plate. This effect was discovered by :
(A) Becquerel (B) Coulomb (C) Faraday (D) Rutherford.
4. The farthest planet from the sun is :
(A) Saturn (B) Venus (C) Uranus (D) Pluto.
5. The image of an object formed on the retina of the eye is
(A) virtual and inverted (B) real and erect (C) virtual and erect (D) real and inverted.
6. Which of the following substances is not magnetic ?
(A) nickel (B) iron (C) brass (D) cobalt.
7. In electric press, the heating-element is wrapped on a sheet which is made of
(A) ebonite (B) iron (C) glass (D) mica.
8. The breathing rate is increased by an increase in the content of
(A) carbon monoxide (B) oxygen (C) carbon dioxide (D) nitrogen
9. Which one of the following glands is considered as master of orchestra of endocrine gland ?
(A) Pituitary (B) thyroid (C) adrenal (D) Islets of langerhans.
10. McLeod Gauge is used to measure
(A) high pressures (B) quantity of rain (C) low pressures (D) atmospheric pressures.
11. Atomiser is an instrument used for
(A) breaking the atom (B) making an atom bomb (C) spraying oil or any other volatile liquid (D) for measuring size of an atom.
12. The temperature at which Centigrade and Fahrenheit thermometers indicate the same reading is :
(A) -80° (B) -40° (C) $+80^{\circ}$ (D) $+40^{\circ}$
13. A phonograph is used to :
(A) send sound waves at a distance
(B) find the velocity of sound
(C) record sound
(D) reproduce sound
14. Chlorophyll does not absorb
(A) red colour of light (B) green colour of light (C) blue colour of light (D) yellow colour of light
15. The long form periodic table is based on the researches of
(A) Dobereiner (B) Mendel (C) Newlands (D) Moseley.
16. Insuline is secreted by
(A) gastric glands (B) islets of langerhans (C) pancreas (D) thyroid

- 17 Who is considered to be the father of genetics ?
(A) Muller (B) Mendel (C) Watson (D) Hopkins
- 18 Enzymes, which act as catalysts, are made up of
(A) proteins (B) fats (C) carbohydrates (D) minerals
- 19 Theory of natural selection was given by
(A) Mendel (B) Lamarck (C) Huxley (D) Darwin
- 20 Which one of the following is best source of vitamin C
(A) Milk (B) Banana (C) Curd (D) fresh oranges.

Answer

1. D 2. D 3. A 4. D 5. D 6. C 7. D
8. C 9. A 10. C 11. C 12. B 13. B 14. C
15. D 16. B 17. B 18. A 19. D 20. D

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Science News

Earth Rotation Slowing Down

Days are 0.07 seconds longer now than a day in the year 1876 B.C., according to scientists who studied ancient Chinese records of solar eclipses to learn how much earth's rotation is slowing.

"Just as a spinning ice skater slows down extending her arms, earth's rotation on its axis slows down as tidal interactions make the moon orbit earth more quickly and become more distant from the planet", said Mr. Kevin Pang of the National Aeronautics and Space Administration's Jet Propulsion Laboratory. According to him, four billion years ago, the moon was only one-third as far away as it is now, and the day was eight hours long at the time. This study has been published in the British journal, *Vistas in Astronomy*.

Mr. Pang and his co-authors determined that compared to today, the length of a day was 0.042 seconds shorter in 899 B.C. and 0.07 seconds shorter in 1876 B.C.

Other studies have shown, earth's rotation varies slightly over time because the oceans and atmosphere produce drag on the planet's topography, and because molten rock within the earth slashes against solid rock to produce a similar drag.

According to Mr. Pang, the knowledge of how the earth rotation rate changes helps us

understand things like the interaction between the ocean, solid earth and atmosphere, and tells us something about the interior of the earth.

While ancient Chinese annals report thousands of eclipses, the research scholars limited themselves to those that occurred at sunrise or sunset, allowing them to compute the time of the eclipses. Knowing the time, along with the fact that the eclipses were visible from China, the scientists were able to calculate how much earth's rotation had slowed since the dates the eclipses occurred. For example, had the day always been 24 hours long, the 899 B.C. eclipse would have been seen in the Middle East instead of China, Mr. Pang explained.

Mr. Pang's calculations of the rate at which earth's rotation is slowing are consistent with previous studies, but extend further back in time. The oldest Arabian and Babylonian records of solar eclipses date to about 700 B.C. Mr. Pang's findings on the 899 B.C. eclipse were first reported in early 1987. In that study he and his colleagues studied ancient Chinese chronicles, called the *Lianbo*—annals, which mentioned a time when "the day dawned twice".

By performing a computer simulation of the history of the earth's rotation around the sun, they determined the phase that the moon eclipsed the sun just after dawn on April 21, 899 B.C. That let them figure out the earth's rotation rate at the time and also place a date on the reign of King Yi of the Western Zhou dynasty.

In this study, they were able to compute the time of the November 13, 532 A.D. eclipse by studying records of the Wei dynasty, and of the October 16, 1876 B.C. eclipse by analyzing the *Xiang Shu*, a book of records edited in about 500 B.C. by Confucius.

Mr. Pang said, some people incorrectly assume that earth's gravity pulls the moon closer to earth. But the moon's gravity creates a tidal bulge in earth's oceans. Because the

earth rotates on its axis the bulge moves ahead of the moon as the moon orbits earth. So gravity from the bulge exerts pull on the moon, speeding the moon in its orbit and transferring momentum that gradually pushes the moon further from earth.

As for the length of a day, he said "It just keeps getting longer and longer".

New Evidence on Mass Extinction

Researchers who contend that dinosaurs died because a comet or asteroid struck earth 66 million years ago say they have found evidence that a similar catastrophe caused the most recent mass extinction about 11 million years ago.

According to Dr. Frank Asaro, a nuclear chemist of Lawrence Berkeley Laboratory, the findings indicate the impact of a large extra-terrestrial body on the earth that could have caused extinction of 25% of the species on the planet between 10 million and 11.7 million years ago.

If the theory is confirmed, three mass extinctions, including one about 38 million years ago, will be blamed on comets or asteroids by a team of researchers from the laboratory and the University of California's Berkeley and Santa Barbara Campuses. The team was led by the late Nobel laureate physicist, Luis Alvarez.

Dr. Asaro said evidence that comet or asteroid impacts caused three mass extinctions supports a more controversial theory that extinctions occur at roughly 26 million to 30 million years intervals when comets are hurled towards the earth by the gravity of an undiscovered companion star of the sun, nicknamed the "Death Star" or "Nemesis".

Other new studies bolster support for rival theories that blame mass extinctions on gigantic volcanic eruptions, on changes in sea level or on global climatic changes unrelated to objects crashing on earth.

The studies were presented at a four-day conference "Global Catastrophes in Earth History" held at Utah in October.

Diamonds from Sewer Gas

The U.S. Naval Laboratory scientists claim they can convert sewer gas into diamonds and eventually turn the waste material into useful commercial products. The scientists pointed out that diamonds are only the crystalline form of carbon. All they did was to obtain carbon for their process from sewer gas which is rich in methane and carbon dioxide.

The sewer gases were passed by the scientists over a glowing hot tungsten filament inside a chamber. A film of tiny diamond crystals appeared on a relatively cooler surface just below the filament. The largest particle obtained was about half a millimetre wide.

The scientist also discovered that when the flame from an ordinary oxygen-acetylene welding torch was played on a solid surface, a layer of diamonds was formed.

Mr. James Butler, a chemist involved in both experiments, said, "Probably most welders have been making diamonds without knowing it". Diamonds thus made were either too small or too impure to be used as jewellery. However, they were as hard as diamonds formed by other methods.

Explaining the industrial applications of the process, Mr. Butler said that diamond films could be deposited on metal surface to make tools and bearings more wear-resistant, on glass lenses to make them scratch-proof or on hard discs to prevent damage if their magnetic reading "heads" touch them.

Mr. Butler also expressed the view that computer chips made of diamond would operate better at temperatures that destroyed silicon chips.

New Device to Keep Heat Alive

Doctors have evolved a small mechanical

device to keep alive for several months patients requiring a heart transplant, pending the search for a donor heart, according to the *Washington Post*.

The "left ventricular assist device" designed to help the heart pump oxygenated blood to the rest of the body was implanted in a 57 years old man by a team of surgeons headed by Dr. John Macoviak at the Washington Hospital Centre in a four hour operation, the first of its kind.

The device kept John L. Hancock of West Virginia alive until new heart could be found for transplantation. Mr. Hancock had suffered a heart attack and was brought to Washington in a serious condition. Hancock's heart was 70% dead at that time and as no donor heart was available immediately, it was decided to use the device which researchers believe may ultimately save thousands of people who die every year of severe heart diseases.

After the surgery, Dr. Macoviak, Director of Heart Transplants at the Hospital Centre said that the pump was working very well. As in the case of Mr. Hancock, the device is usually used to assist the left ventricle, which performs 80% of the heart's work and is usually the cause of heart ailments.

The pump is powered by compressed air generated by a television sized console to which the patient must consistently be tethered while he is in hospital, awaiting the heart transplant.

The device he has used "will probably serve as a prototype for the permanent implantable left ventricular assist device". This, he said, could benefit as many as 10,000 patients annually.

Victor Poiren, a Massachusetts scientist who invented the assist device used, said that this device was different from all others because it was implanted in the patient's body rather than attached through the patient's skin with tubes.

Various types of ventricular assist devices are under experimentation throughout the USA and about 180 patients have had such devices implanted as a bridge to heart transplants since 1975.

New Therapy for Phobias

Eighty per cent of the 11 million U.S. adults suffering from phobias of anxiety disorders could be successfully treated in eighty weeks with behaviour therapy, drugs or both. But despite advances in dealing with phobias, less than 25% of sufferers receive treatment, doctors at the annual conference of the Phobia Society of America said.

The treatment of phobias and panic attacks has received serious attention from the psychiatric and medical community only in the last eight years according to the Phobia Society, an organisation of some 5,000 health professionals. The severity of these disorders is often overlooked.

Doctors said one of the most promising treatments reported at the conference was the eight-week, 11-session programme for panic disorder developed by Dr. David Barlow, which involves confronting patients with their fears in a controlled situation. For example, a patient with fear of not breathing would be encouraged to hyperventilate. This was contrasted with more traditional relaxation methods for treating panic attacks.

The relaxation method had a 40% success rate while 85% of patients who underwent the behaviour treatment were panic free at the end of the treatment, Dr. Barlow said.

Further Use for Aids Drug Found

The drug AZT the most effective AIDS medication available, can be beneficial for treatment of a mental dysfunction often found in patients with this disease, according to a report in the *New England Journal of Medicine*. "The results of this study suggest HIV associated

cognitive abnormalities may be partially ameliorated after the administration of Zidovudine (AZT)", Dr. Frederick A. Schmitt and colleagues write. The AIDS, which is caused by the HIV, often affects a person's mental capacity. Patients who have neurological symptoms of HIV infection and the AIDS often have a fairly rapid progression of symptoms and an extremely poor prognosis, with an average survival period of four months.

Dr. Schmitt and his colleagues studied 281 patients with AIDS or AIDS-related complex, a milder form of the disease, breaking them into two similar groups one of which received AZT and the other a placebo.

Patients with AIDS who received AZT had better scores than patients treated with a placebo when tested for attention, memory, motor skills and general mental speed over a 16 week period.

Oil Slicks Polluting Indian Seas

Oil slicks from tanker-ships are polluting the Indian Ocean threatening marine life.

The problem may not appear to be as serious as in the North Sea, but intense occurrence of oil slicks have been sighted in the northern Indian Ocean, scientists said.

The source of these oil slicks is mostly the washing of the bilge and bunker of tankers on their way to the Gulf ports when the tankers' contents are emptied into the sea.

According to scientists at the National Institute of Oceanography, Goa two of the world's major oil tanker routes pass through the Indian Ocean, transporting 80% of the Gulf's oil output. The tankers discharge into the sea oil left in their hold and use sea water for cleaning, in violation of maritime and environmental laws. Under shipping laws cleaning and washing of tankers should be done only at ports-of-call.

Oil discharged into the sea from tankers undergoes changes with the evaporation of its

lighter fractions. Part of the oil gets dissolved in sea water and the rest is transformed into tar lumps that either sink to the bottom or are washed ashore on the beaches. About 8,400 tonnes of these tar residues are produced annually by oil slicks in the Arabian Sea. In the southern Bay of Bengal, it ranges at 1,100 tonnes a year.

Similarly, more than 3 million tonnes of dissolved petroleum hydro-carbons are expected to be present in the upper 20 metres of the Arabian Sea at any given time.

In the southern Bay of Bengal the presence of these carbons is estimated at about 400,000 tonnes.

Two years' observation of the beaches of Kutch and Kerala along the west coast indicates deposition of 750 to 1,000 tonnes of tar-like residues, mostly during the south-west monsoon. The quantity of oil polluting the ocean is proportional to the volume transported by tankers on the routes.

The NIO scientists computed that the entry of tar into the Arabian Sea was 32,800 tonnes and in the Bay of Bengal 11,700 tonnes between 1973 and 1983. They also found that the tar occurring on the Indian seas remained more or less unchanged for 30 to 90 days.

New Frontiers in Neem Research

Research on neem is expanding worldwide following the discovery by scientists that neem derivatives repel 123 species of insects including pests of stored grain.

Centuries before petroleum-based pesticides were available, farmers in the Indian subcontinent protected their crops with natural insect repellents found in the fruits and leaves of the neem tree. In rural India, putting dried neem leaves between layers of woollens to protect them against moths is an age-old practice. In Sri Lanka, farmers burn neem leaves to generate smoke to fumigate storehouses of rice and pulses against insect pests. In Pakistan, neem

leaves are mixed with grain stored in gunny bags.

The insect-repellent qualities of oil extracted from neem fruit, and of cake made from its residue, are being studied in a programme to develop biological pesticides that cause no ecological damage. The International Rice Research Institute, Manila is cooperating in neem research with scientists in India, the Philippines, West Germany, Britain, Israel and the USA.

The IRRI is also exploring the feasibility of botanical pest-control in rice-based farming systems in cooperation with scientists in India, Bangladesh, China and the Philippines through a project funded by the Asian Development Bank and the Swiss Development Corporation.

Neem oil and its residue contain a complex array of novel chemicals with diverse behavioural and physiological effects on insects. The IRRI studies have shown that insects feed less, grow poorly and lay fewer eggs on susceptible rice plants that have been sprayed with neem oil. The effects are similar with sucking insects like the brown plant-hoppers and chewing insects like the rice leaf-folder and the ear-cutting caterpillar. Scientists of the Indian Agricultural Research Institute in New Delhi have reported an anti-feeding property of neem seed kernels against the desert locust.

A neem tree becomes fully productive in about 10 years. In nature one tree produces 30 kg of seed a year, yields 6 kg of neem oil and 24 kg of neem cake.

India alone is estimated to have over 14 million neem trees. The total yield is about 83,000 tonnes of neem oil and 330,000 tonnes of oil-cake a year.

Space Scavenger Developed

After having littered the space with debris, space technologists have now come out with a cosmic scavenger that will grab the debris, break it into bits using solar rays, collect the bits in a bin and send the garbage back to earth.

Dr. Kumar Ramohalli, a scientist of

Arizona University told the World Space Conference, Bangalore that his team was testing a junk-eating satellite called Autonomous Space Processor for Orbital Debris, (ASPOD) for cleaning the debris in outer space.

Four million tonnes of space-age junk orbits the earth, travelling at 10 km a second. Even a small piece of the size of 25 paise coin will strike a satellite in space with the destructive force equivalent to 1 kg of TNT.

Using its computer controlled TV eyes, ASPOD would spot the debris and position itself against it using onboard engines, Dr Ramohalli said. Its lobster like claws would then grab the object and break it into bits using concentrated solar energy and stow the bits in a bin. ASPOD would then manoeuvre to another debris, continuing the cutting and collection process until the garbage bin is filled. With its bin full of space garbage, it would be retrieved by the space shuttle and directed to a splashdown recovery or an atmospheric re-entry for safe burn-up.

The American scientist said that initial feasibility demonstration with a small scale model was complete. The cosmic clean-up device is meant for removal of large pieces of orbital debris. Space debris was increasing at the rate of 10% a year, which meant that by 1990, the probability that a spacecraft would be hit was more than 20% of what it is today.

Meanwhile, a status report on the debris issue, released at the conference, said hazards from debris had received worldwide concern as more countries entered the spacefaring community. According to the report, over 19,000 pieces of space debris have been catalogued since 1957. The major source of debris in space was the fragmentation of satellites, as in February 1988, there were 379 objects in geostationary orbit. In the long run, solving the space debris problem will require action by all major spacefaring nations and organisations.

Under the 1967 outer space treaty, States have an affirmative duty to avoid allowing debris to constitute harmful interference

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General Editor
Indian Educational Review
Journals Cell, NCERT ~
10-B, Ring Road, I P Estate, New Delhi-110016

Published at the Journals Cell by the Secretary, National Council of Educational Research and Training, Sri Aurobindo Marg, New Delhi-110016 and printed at Deep Printers 3/26, Ramesh Nagar, New Delhi-110015

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